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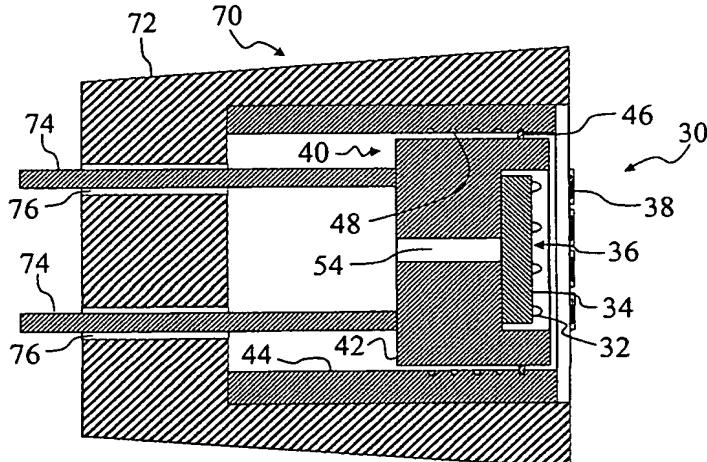
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(54) Title: VARIABLE OPTICS SPOT MODULE



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(57) Abstract: A spot module that has a selectable light output includes a substrate (14, 34, 84, 112, 142, 152). A plurality of optical sources (114A, 114B, 114C, 114D) are arranged on the substrate (14, 34, 84, 112, 142, 152). Each optical source (114A, 114B, 114C, 114D) includes at least one light emitting diode (116A, 116B, 116C, 116D, 146A, 146B, 146C, 146D, 156A, 156B), and at least one optical element (18, 38, 88) in operative communication with the at least one light emitting diode (116A, 116B, 116C, 116D, 146A, 146B, 146C, 146D, 156A, 156B) and having a pre-defined optical prescription. A zoom apparatus (20, 40, 90) supports the optical elements (18, 38, 88) of the optical sources (114A, 114B, 114C, 114D). The zoom apparatus (20, 40, 90) adjusts an axial separation between the at least one light emitting diode (116A, 116B, 116C, 116D, 146A, 146B, 146C, 146D, 156A, 156B) of each optical source (114A, 114B, 114C, 114D) and its corresponding at least one optical element (18, 38, 88).

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*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

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## VARIABLE OPTICS SPOT MODULE

### BACKGROUND OF THE INVENTION

### FIELD OF THE INVENTION

The invention relates to the lighting arts. It is especially applicable to the packaging of light emitting diodes (LED's) to form a spot light, flashlight, or other lamp type that produces a collimated or partially collimated beam, and will be described with particular reference thereto. However, the invention will also find application in packaging of LED's, semiconductor lasers, halogen bulbs, and other light emitting elements for spot lighting, flood lighting, and other optical applications.

### DISCUSSION OF THE ART

Spot light lamps emit a collimated or partially collimated beam of light (e.g., a conical beam), and are employed in room lighting, hand-held flash lights, theater spot lighting, and other applications. Examples of such lamps include the MR-series halogen spot lights which incorporate an essentially non-directional halogen light bulb arranged within a directional reflector, such as a parabolic reflector. The MR-series halogen spot lights are commercially available with or without a front lens, and typically include electrical connectors disposed behind the parabolic reflector, i.e. outside of the range of the directed beam. The reflector, optionally in cooperation with a front lens, effectuates collimation of the halogen light bulb output to produce the collimated or conical light beam. The MR-series spot lights are available in a range of sizes, wattages, color temperatures, and beam angles. However, the MR-series spot lights do not include adjustable beams.

The Maglite® flashlight is a prior art device that has an adjustable spot beam. An incandescent light bulb is arranged inside an essentially parabolic reflector. This device effectuates a variable beam angle ranging from

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a narrow spot beam to a wide, "flood" beam, by including a rotating actuator for moving the reflector axially with respect to the incandescent bulb. This arrangement suffers from significant beam non-uniformity when the light source is strongly defocused. Under conditions of extreme defocusing, the Maglite® flashlight beam exhibits a black spot at the beam's center.

Lamps which utilize one or more LED's as the source of light are becoming more attractive as the light output intensities of commercial LED's steadily increase over time due to design, materials, and manufacturing improvements. Advantageously for spot module applications, commercial LED's typically have a lensing effect produced by the epoxy encapsulant that is usually employed to seal the LED chip from the environment. Hence, these commercial LED's are already somewhat directional, and this directionality can be enhanced using an external lens. Additionally, LED's that emit white light of reasonably high spectral quality are now available. In spite of continuing improvements in LED light output, at present an individual LED is typically insufficiently bright for most lighting applications. Nonetheless, due to the small size of LED's, this intensity limitation can be obviated through the use of a plurality of closely packed LED's that cooperate to produce sufficient light.

Application of LED's to spot lighting applications, and especially to spot lighting applications in which the LED-based lamp is contemplated as a retrofit for replacing an existing lamp that employs another lighting technology (e.g., a retrofit for replacing an MR-series halogen lamp) is complicated by the use of multiple LED's as the light source. The spatially distributed nature of an LED source array greatly reduces the effectiveness of conventional parabolic reflectors which are designed to collimate and direct light emanating from a point source, such as light generated by a halogen or incandescent bulb filament. Furthermore, a front lens of the type optionally included in an MR-series halogen spot lamp is ill-suited for collimating light from a plurality of LED's, because most of the LED's are not positioned on the optical axis of the lens. Thus, the optical systems of existing spot lamps, both with and without variable beam angle, are relatively ineffective when used in conjunction with LED light sources.

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The present invention contemplates an improved light source or lamp that overcomes the above-mentioned limitations and others.

#### BRIEF SUMMARY OF THE INVENTION

In accordance with one embodiment of the present invention, a spot module that has a selectable light output includes a substrate. A plurality of optical sources are arranged on the substrate. Each optical source includes at least one light emitting diode, and at least one optical element in operative communication with the at least one light emitting diode and having a pre-defined optical prescription. A zoom apparatus supports the optical elements of the optical sources. The zoom apparatus adjusts an axial separation between the at least one light emitting diode of each optical source and its corresponding at least one optical element.

In accordance with another embodiment of the present invention, a lamp is disclosed. An LED module includes at least one LED arranged on a substrate. An optical system includes at least one lens in optical communication with the LED module. A zoom apparatus selectively adjusts the relative axial separation of the optical system and the LED module.

In accordance with yet another embodiment of the present invention, a lamp is disclosed, that includes a substrate. A first lighting unit includes a first light emitting diode (LED) arranged on the substrate and a first lens element having a first optical prescription and being arranged to interact with light produced by the first LED. A second lighting unit includes a second light emitting diode (LED) arranged on the substrate and a second lens element having a second optical prescription and being arranged to interact with light produced by the second LED.

Numerous advantages and benefits of the present invention will become apparent to those of ordinary skill in the art upon reading and understanding the following detailed description.

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#### BRIEF DESCRIPTION OF THE DRAWINGS

The invention may take form in various components and arrangements of components, and in various steps and arrangements of steps. The drawings are only for purposes of illustrating a preferred embodiment and are not to be construed as limiting the invention.

FIGURE 1 shows an isometric view of a zoomable spot lamp that suitably practices an embodiment of the invention.

FIGURE 2 shows a schematic cross-sectional view of a zoomable spot lamp that suitably practices an embodiment of the invention, the lamp being shown as adjusted to produce a wide-angle flood beam.

FIGURE 3 shows a schematic cross-sectional view of the lamp of FIGURE 2, adjusted to produce a narrow-angle spot beam.

FIGURE 4 shows a front view of the lamp of FIGURE 2, looking directly into the beam, with dotted lines indicating the hidden sleeves of the zoom apparatus and the interlocking mechanism.

FIGURE 5 shows a schematic cross-sectional view of the lamp of FIGURE 2 in a first mounting configuration.

FIGURE 6 shows a schematic cross-sectional view of the lamp of FIGURE 2 in a second mounting configuration.

FIGURE 7 shows a schematic cross-sectional view of a zoomable spot lamp that suitably practices another embodiment of the invention, the lamp being shown as adjusted to produce a wide-angle flood beam.

FIGURE 8A shows a front view of the lamp of FIGURE 7, looking directly into the beam, with the zoom apparatus rotated at a reference position, herein designated as 0°, between the first and second sleeves.

FIGURE 8B shows a front view of the lamp of FIGURE 7, looking directly into the beam, with the second sleeve rotated 120° compared with its reference orientation of FIGURE 8A.

FIGURE 8C shows a front view of the lamp of FIGURE 7, looking directly into the beam, with the second sleeve rotated 240° compared with its reference orientation of FIGURE 8A.

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FIGURE 8D shows a front view of the lamp of FIGURE 7, looking directly into the beam, with the second sleeve rotated slightly more than 240° compared with its reference orientation of FIGURE 8A.

FIGURE 9 shows a perspective view of another lamp or light source which suitably practices an embodiment of the invention;

FIGURE 10 shows a cross-sectional view of the lamp or light source of FIGURE 9 taken perpendicular to the substrate along the Line L-L shown in FIGURE 9;

FIGURE 11 shows an schematic representation of the electrical configuration of the lamp or light source of FIGURES 9 and 10;

FIGURE 12 shows a perspective view of a lamp or light source which suitably practices another embodiment of the invention; and

FIGURE 13 shows a perspective view of a lamp or light source which suitably practices yet another embodiment of the invention.

#### DETAILED DESCRIPTION OF THE INVENTION

With reference to FIGURE 1, a lamp that suitably practices an embodiment of the invention is described. A lamp or light source 10 includes a plurality of light emitting diodes (LED's) 12 arranged on a base or substrate 14, the combination of which forms an LED module 16. A plurality of lenses 18 are arranged in conjunction with the LED's 12, such that each LED 12 lies on the optical axis of one of the lenses 18. The lenses 18 effectuate a collimation of the light emitted by the LED's 12, so that the lamp output is a collimated or conical beam having a desired angle of divergence. Preferably, the LED's 12 are positioned closely to the lenses 18 to maximize the light captured. For this reason, the lenses 18 should be fast lenses, i.e., should have a low f number. These preferred lens optical properties are not readily obtainable using conventional lenses. Accordingly, fresnel lenses are advantageously used for the lenses 18 to provide very low f number behavior in a reasonably sized lens.

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In the illustrated embodiment of FIGURE 1, there is a one-to-one correspondence between lenses 18 and LED's 12. That is, each LED 12 is associated with a single lens 18. This in turn allows each LED 12 to lie on the optical axis of its corresponding lens 18, which maximizes the optical efficiency of the combination. In other words, the spatial pattern of the lenses 18 corresponds with the spatial pattern of the LED's 12.

The lenses 18 are arranged on a zoom apparatus 20 which together with the lenses form an adaptive optical system 22. The optical system 22 is relatively adjustable with respect the LED module 16 to enable a selectable distance separation along the optical axis between the lenses 18 and the LED's 12.

Because the lamp 10 is intended for lighting applications, the LED's 12 preferably emit light at high intensities. This entails electrically driving the LED's 12 at relatively high currents, e.g., as high as a few hundred milliamperes per LED 12. Because LED light emission is very temperature-sensitive, the heat dissipated in the LED's 12 as a consequence of the high driving currents is advantageously removed by a heat sink 24 which is thermally connected with the substrate 14.

With reference now to FIGURES 2 through 4, a lamp 30 that suitably practices an embodiment of the invention in which the zoom apparatus operates on a mechanical sliding principle is described. LED's 32 are arranged on a substrate 34 forming an LED module 36. A plurality of lenses 38, which are preferably Fresnel lenses, are arranged in correspondence with the LED's 32, with each LED 32 lying on the optical axis of an associated lens 38. A sliding zoom apparatus 40 includes two slidably interconnecting elements or sleeves 42, 44. The LED module 36 is arranged on or in the first sleeve 42 in a fixed manner. The lenses 38 are arranged on or in the second sleeve 44, also in a fixed manner. It will be appreciated that zoom apparatus 40 of the lamp 30 effectuates beam width adjustment through the relative motion of the sleeves 42, 44.

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The configuration of the zoom apparatus 40 shown in FIGURE 2 corresponds to a minimum relative separation between the LED's 32 and the lenses 38. This configuration produces a wide beam, i.e., a conical beam with a wide angle of divergence, sometimes called a flood light.

The configuration of the zoom apparatus 40 shown in FIGURE 3 corresponds to a maximum relative separation between the LED's 32 and the lenses 38. This configuration produces a narrow beam, i.e., a conical beam with a small angle of divergence, sometimes called a spot light.

A sliding zoom apparatus can optionally effectuate continuous zoom adjustment (not shown). For continuous zoom adjustment, the sleeves should be of sufficiently close relative tolerances so that the frictional force between the two sleeves 42, 44 inhibits unintended sliding slippage therebetween.

Alternatively, as shown in the illustrated embodiment of FIGURES 2 and 3, the zoom apparatus 40 is an indexed zoom apparatus. A projection or stop 46, which can be a single projection, a plurality of projections, or an annular projection, extends from the first sleeve 42 and is selectively moved into one of five recesses or stop positions 48, which can be annular grooves, holes, or the like. The projection(s) 46 and the recesses 48 are mutually adapted to enable relative movement of the sleeves 42, 44 to selectively move the stop 46 to a selected stop position 48. The projections or stop 46 and the recesses or stop positions 48 cooperate to bias the zoom apparatus into certain pre-selected axial spacings or stop positions. It will be appreciated that such an index system tends to reduce slippage between the two sleeves 42, 44 versus a similar continuous zoom adjustment which relies upon frictional force to prevent slippage. Of course, the index system of FIGURES 2 and 3 is exemplary only, and many variations thereof are contemplated, such as placing the stop onto the first sleeve and the recesses onto the second sleeve, using other than five stop positions, etc.

With reference to FIGURE 4, in addition to the zoom indexing system exemplarily effectuated by projection(s) 46 and recesses 48, the lamp 30

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also includes an advantageous interlocking mechanism including a linear projection 50 aligned along the sliding direction of the sliding zoom apparatus 40 and extending inwardly from the second sleeve 44 toward the first sleeve 42, and a corresponding linear depression 52 that receives the linear projection 50. This interlocking mechanism prevents relative rotation between the first and second sleeves 42, 44 so that the LED's 32 are maintained centered on the optical axes of the lenses 38.

With reference to FIGURES 2 and 3, the lamp 30 also includes one or more electrical conduits 54 through which wires or other electrical conductors (not shown) connect the LED's to an associated power supply (not shown). Although an exemplary single conduit 54 is shown, numerous variations are contemplated, such as separate conduits for each LED 32.

In addition, electrical components such as a printed circuit board that electrically connects the LED's 32 and has optional driving electronics operatively arranged thereupon, metallized connections, an associated battery or other electrical power supply, etc. are also contemplated (components not shown). It will be recognized that such electrical components are well known to those skilled in the art.

With reference to FIGURE 5, a mounting configuration 60 for the lamp 30 of FIGURES 2 through 4 is described. In the mounting configuration 60, the inner sleeve 42 remains fixed relative to a mounting element 62, while the sliding movement of the outer sleeve 44 effectuates the zoom adjustment. The mounting element 62 could, for example, be the approximately cylindrical body of a hand flashlight that contains associated batteries to power the lamp 30, in which case movement of the outer sleeve 44 is effectuated manually by the user. Alternatively, for a theater stage spotlight mounting configuration, the movement of sleeve 44 could be mechanized. It will be appreciated that the mounting configuration 60 is rather simple to construct because the adjustable outer sleeve 44 is accessible.

With reference to FIGURE 6, another mounting configuration 70 for the lamp 30 of FIGURES 2 through 4 is described. In the mounting

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configuration 70, the outer sleeve 44 remains fixed relative to a mounting element 72, while movement of the inner sleeve 42 effectuates the zoom adjustment. In this case, the inner sleeve 42 is relatively inaccessible from outside the mounting configuration 70, and so in the embodiment of FIGURE 6 one or more posts 74 are rigidly affixed to the inner sleeve 42 and pass through passthroughs 76 in the mounting element 72 to provide handles or shafts by which the inner sleeve 42 is slidably adjusted to effectuate the zoom. The mounting configuration 70 is therefore more complex versus the mounting configuration 60 of FIGURE 5. However, the mounting configuration 70 has the advantage of fully containing the lamp 30 within the mounting element 72 so that a lighting device that employs the configuration 70 has definite and fixed outside dimensions. The one or more posts 74 are also easily adapted to connect with a motor (not shown) to effectuate a mechanized zoom adjustment.

With reference to FIGURE 7, a lamp 80 that suitably practices another embodiment of the invention in which the zoom apparatus operates on a mechanical rotation principle is described. LED's 82 are arranged on a substrate 84 forming an LED module 86. A plurality of lenses 88, which are preferably Fresnel lenses, are arranged in the same pattern as the LED's 82. The rotating zoom apparatus 90 includes two threadedly interconnecting elements or sleeves 92, 94. The LED module 86 is arranged on or in the first sleeve 92 in a fixed manner. The lenses 88 are arranged on or in the second sleeve 94, also in a fixed manner. Thus, by relatively screwing the first and second sleeves 92, 94 into or out of each other using the cooperating threads 96, 98 disposed on the outside of the first sleeve 92 and the inside of the second sleeve 94, respectively, the relative axial separation of the LED's 82 and the lenses 88 is adjusted. The first sleeve 92 preferably includes one or more electrical conduits 104 which are analogous to the conduit or conduits 54 of the embodiment of FIGURE 2.

Although the LED's 82 and the lenses 88 are arranged in the same spatial pattern, it will be recognized that the rotating motion in general results in a misalignment of the LED's 82 off the optical axes of the lenses 88. However,

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for certain relative rotational orientations of the sleeves 92, 94, the two patterns align, as shown in FIGURE 8A. The relative rotational orientation shown in FIGURE 8A is herein designated as  $0^\circ$  and serves as a reference orientation. Furthermore, a specific LED  $82_0$ , and a specific lens  $88_0$ , are shown in bold in FIGURE 8A and will be tracked during zoom adjustment using FIGURES 8B and 8C in the discussion which follows.

With reference to FIGURE 8B, the reference orientation has been changed by rotating the second sleeve 94 counter-clockwise by  $120^\circ$ . Two changes result from the  $120^\circ$  rotation. First, the axial separation of the LED's 82 and the lenses 88 changes by an amount related to the spacing of the threads 96, 98 due to the screwing action. Second, the lens  $88_0$  is no longer axially aligned with the LED  $82_0$ , but rather now axially aligns with another LED as seen in FIGURE 8B.

With reference to FIGURE 8C, the second sleeve 94 has been rotated counter-clockwise by another  $120^\circ$  ( $240^\circ$  total rotation versus FIGURE 8A). The axial separation of the LED's 82 and the lenses 88 is again changed by an amount related to the spacing of the threads 96, 98, and the lens  $88_0$  axially aligns with yet another LED as seen in FIGURE 8C. Although not illustrated as a separate figure, it will be recognized that a third counter-clockwise rotation of  $120^\circ$  would bring the total rotation versus FIGURE 8A up to  $360^\circ$ , i.e. one complete rotation, and would re-produce the pattern alignment shown in FIGURE 8A, but with a change in axial spacing between the LED's 82 and the lenses 88 corresponding to the spacing of the threads 96, 98.

In one aspect of the embodiment, the threads 96, 98 have thread joints, indented stops or another mechanism (not shown) to bias the zoom apparatus 90 into indexed positions such as those shown in FIGURES 8A, 8B, and 8C wherein the lens 88 pattern aligns with the LED 82 pattern. It will be recognized that if the lens 88 pattern and the LED 82 pattern each have an n-fold rotational symmetry, then separation of the rotational stop positions by integer multiples of  $360^\circ/n$  enables stop positions for which each LED 82 is axially aligned with one of the plurality of lenses 88. In the exemplary

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embodiment shown in FIGURES 8A, 8B and 8C, the patterns have six-fold rotational symmetry ( $n=6$ ), and the stop positions are separated by  $2 \times (360^\circ/n) = 120^\circ$  rotations.

In another aspect of the embodiment, the rotation of the zoom apparatus 90 can also be continuous with no index biasing. In this case the frictional interaction between the threads 96, 98 should be sufficient to counteract slippage of the zoom apparatus 90.

FIGURE 8D shows a relative rotational orientation of the LED 82 pattern and the lenses 88 pattern wherein the LED's 82 are not axially aligned with the lenses 88, but rather are relatively positioned slightly off-axis. It will be recognized that a relative pattern orientation such as that shown in FIGURE 8D can be obtained either with or without index biasing. Such a slightly off-axis relative orientation produces defocusing which can provide further freedom for adjusting the light beam properties. In FIGURE 8D, the second sleeve 94 has been rotated to an angle A relative to the reference rotational orientation of FIGURE 8A, where the angle A is slightly greater than the  $240^\circ$  orientation that would produce pattern alignment.

In the embodiments of FIGURES 1-8D the LEDs are shown as substantially similar, and the beam spot size or other beam characteristics is changed by relative mechanical movement of a lensing system and an LED assembly. However, the LEDs can be different. Moreover, in other embodiments, described next, beam spot size or other beam characteristics are changed by selectively energizing selected LEDs or sets of LEDs in which the LEDs or sets of LEDs are different and/or have different coupled optics.

With reference to FIGURE 9, a lamp or light source 110 includes a substrate 112 which in the embodiment of FIGURE 9 is circular in shape. Arranged on the substrate 112 are a plurality of optical sources or lighting units 114A, 114B, 114C, 114D. Each of the lighting units or optical sources 114A, 114B, 114C, 114D include one or more light emitting diode (LED) components. The optical source 114A comprises eight LED components 116A. The optical source 114B comprises eight LED components 116B. The optical source 114C

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comprises eight LED components 116C. The optical source 114D comprises only a single LED component 116D. In the embodiment of FIGURE 9, the lighting unit 114D that includes only a single LED component 116D is located at the center of the substrate 112. The lighting units 114C, 114B, and 114A are arranged in concentric circular patterns of increasing diameter, respectively, about the lighting unit 114D.

With continuing reference to FIGURE 9 and with further reference now to FIGURE 10, an embodiment of the LED components 116A, 116B, 116C, 116D is described. FIGURE 10 shows a cross-sectional view of the lamp or light source 110 taken perpendicular to the substrate 112 along the Line L-L shown in FIGURE 9. A plurality of wells 120 are formed in the substrate 112 for receiving LED elements 122A, 122B, 122C, 122D that correspond to the LED components 116A, 116B, 116C, 116D, respectively. The substrate 110 is manufactured using a thermal-heat sinking material such as a copper plate. Mounting of the LED elements and electrical contacting thereof are steps that are well known to the art and need not be described herein for an enabling disclosure.

It will be appreciated that the LED elements 122A, 122B, 122C, 122D need not be identical to one another, but can instead include LED elements emitting light at different colors or with different spectral distributions, different optical intensities, and the like. The LED elements 122A, 122B, 122C, 122D can be manufactured from different materials, e.g. LED element 122A can be a group III-nitride LED element emitting blue light, whereas LED element 122B can be a group III-phosphide LED element emitting red light. Furthermore, in the case of a plurality of LED elements comprising a lighting unit or optical source, e.g. the optical source 114A, every LED element of the plurality need not be identical. For simplicity, however, FIGURE 2 shows all the LED elements 122A, 122B, 122C, 122D as being essentially identical.

The LED components 116A, 116B, 116C, 116D also include optical elements such as lenses 124A, 124B, 124C, 124D. In order to effectuate different angular distributions or spatial patterns for the light emitted

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by the lighting units 114A, 114B, 114C, 114D, the corresponding optical elements or lenses 124A, 124B, 124C, 124D each have different optical prescriptions. The lenses 124A, 124B, 124C, 124D can be discrete elements that are mounted above the wells 120. Alternatively, the optical elements 124A, 124B, 124C, 124D can be formed by controlled shaping or molding of an epoxy or resin encapsulant that is used to hermetically seal the LED elements 122A, 122B, 122C, 122D. In the illustrated embodiment of FIGURES 9 and 10, the different optical prescriptions are effectuated by different radii of the conic of the lenses or epoxy "bumps" 124A, 124B, 124C, 124D. Of course, other approaches for effectuating a pre-selected optical prescription can also be employed, such as by using different materials having different refractive indexes for each type of optical element 124A, 124B, 124C, 124D. It will also be appreciated that the optical elements 124A, 124B, 124C, 124D can, in addition to effectuating pre-selected optical prescriptions, also alter the light emitted by the optical sources 114A, 114B, 114C, 114D in other ways. For example, the optical elements or lenses 124A, 124B, 124C, 124D can be selectively tinted to alter the color or spectral distribution of the light passing therethrough in a pre-selected manner.

The embodiment illustrated in FIGURE 10 is exemplary only. Other configurations for the LED components 116A, 116B, 116C, 116D and for the substrate 112 are also contemplated. For example, the substrate 112 can be a printed circuit board (PC board) with the LED elements 122A, 122B, 122C, 122D bonded directly thereto. The wells 120 would typically be omitted in this alternate embodiment.

With reference now to FIGURE 11, the electrical configuration of the embodiment of FIGURES 9 and 10 is described. An associated voltage source V provides electrical power for the light source or lamp 110 that in the embodiment of FIGURES 9 and 11 includes four optical sources or lighting units 114A, 114B, 114C, 114D. The lamp 110 further includes a control unit 130 that has four switches 132A, 132B, 132C, 132D for selectively applying electrical power to the corresponding lighting units 114A, 114B, 114C, 114D. The

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switches 132A, 132B, 132C, 132D can be manual switches, electronically controlled switches, or other switch types. The control unit 130 optionally includes additional elements (not shown) such as a computer interface or components for conditioning the power applied to the lighting units. In the illustrated electrical configuration of FIGURE 11, the four lighting units 114A, 114B, 114C, 114D are independently selectable, and any combination of the lighting units 114A, 114B, 114C, 114D can be selectively powered at any given time. Each of the lighting units 114A, 114B, 114C, 114D has a different optical prescription, obtained in the embodiment of FIGURES 9 and 10 by using different conic radii for the lenses 124A, 124B, 124C, 124D. Thus, by operating only a selected one of the four lighting units 114A, 114B, 114C, 114D four different angular distributions or spatial patterns of emitted light can be selectively obtained. By operating a selected sub-set of the plurality of optical sources 114A, 114B, 114C, 114D, complex combinations of the spatial light distributions of the individual optical sources 114A, 114B, 114C, 114D can be obtained. In a limiting operational case, all four optical sources 114A, 114B, 114C, 114D can be operated simultaneously using the electrical configuration shown in FIGURE 11.

The electrical configuration of FIGURE 11 is exemplary only, and a number of variations thereof are contemplated. As noted previously, the LED elements 122A, 122B, 122C, 122D can be of different types, e.g. GaN LED elements, InGaAlP LED elements, and so forth. In cases where the LED elements comprising the lighting units differ, the control unit 130 optionally includes voltage dividers (not shown) or other power conditioning components that control the power applied to each optical source 114A, 114B, 114C, 114D. Furthermore, as noted previously a given optical source, e.g. optical source 114A, can include LED elements of different types. In this case, the optical source 114A would itself include one or more electrical components (not shown) such as voltage dividers that condition the voltage applied to each LED element within the optical source 114A. In yet another variant, the control unit 130 includes a rheostat, variable voltage divider, or other electrical component (not

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shown) that enables variable power application to the lamp 110 as a whole or to one or more of the individual lighting units 114A, 114B, 114C, 114D that are included in the lamp 110. Such an arrangement advantageously enables the user to control the optical intensity as well as the spatial distribution of the light output.

With reference now to FIGURE 12, a second embodiment 140 of the invention is described. A circular substrate 142 has four lighting units arranged thereon. Each lighting unit includes a plurality of essentially identical LED components. The LED components of each lighting unit differ from the LED components of the other three lighting units. Hence, there are four LED component types 146A, 146B, 146C, 146D arranged on the substrate 142, corresponding to the four lighting units. Unlike the embodiment of FIGURE 9, the embodiment of FIGURE 12 has an equal number of LED components of each type, and the distribution of the LED component types 146A, 146B, 146C, 146D across the substrate 142 is essentially uniform. Although the spatial distribution of the LED component types is uniform, the lamp 140 nonetheless is capable of producing light having at least four selectable spatial or angular distributions because each of the four LED component types 146A, 146B, 146C, 146D has a different optical prescription, as indicated by the different conic radii of the four LED component types 146A, 146B, 146C, 146D. Thus, the corresponding four lighting units each produce light having a different spatial or angular light distribution.

With reference now to FIGURE 13, a third embodiment 150 of the invention is described. A rectangular substrate 152 has two lighting units corresponding to LED components of types 156A and 156B, respectively. The LED component types 156A, 156B have optical elements with essentially similar conic radii. However, different optical prescriptions are obtained by using materials having different refractive indexes for the optical elements of each component type 156A, 156B. Hence, the embodiment of FIGURE 13 has a first angular or spatial light distribution obtained when the first optical source comprising the LED components of type 156A are activated; and a second

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angular or spatial light distribution obtained when the second optical source comprising the LED components of type 156B are activated. Optionally, a third angular or spatial light distribution can be obtained by activating both the first and the second optical sources together, the third angular or spatial distribution operatively combining the first and the second light output distributions.

Those skilled in the art will appreciate that embodiments of the type 110, 140, 150 in which beam spot size or other beam characteristics are changed by selectively energizing selected LEDs or sets of LEDs are readily combined with the embodiments of the type 10, 30, 80 in which the beam characteristics are varied by relative mechanical movement of a lensing system and an LED assembly.

For example, the light source 110 of FIGURE 9 has an eight-fold rotational symmetry that is particularly suitable for use in a rotationally adjustable spot module lamp similar to the lamp 80 of FIGURE 7. The light source 110 suitably replaces the LED module 86 of the lamp 80. The lenses 124 in one contemplated embodiment are located on the second sleeve 94, that is the lenses 124 replace the lenses 88 of the spot module 80. In another contemplated embodiment the lenses 124 are affixed to the light source 110 as shown in FIGURE 9, and the lenses 88 are separate lenses that cooperate with the lenses 124 to provide the selected optical focusing. The light sources 140, 150 are less suitable for a rotationally adjustable spot module lamp, since these sources 140, 150 would require a 360° rotation. However, any of the light sources 110, 140, 150 are suitably used in conjunction with a slidably adjustable spot module lamp similar to the lamp 30 of FIGURES 2-4.

The invention has been described with reference to the preferred embodiments. Obviously, modifications and alterations will occur to others upon reading and understanding the preceding detailed description. It is intended that the invention be construed as including all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.

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WHAT IS CLAIMED IS:

1. A spot module having a selectable light output, the spot module including:

a substrate (14, 34, 84, 112, 142, 152);

a plurality of optical sources (114A, 114B, 114C, 114D) arranged on the substrate (14, 34, 84, 112, 142, 152), each optical source (114A, 114B, 114C, 114D) including:

at least one light emitting diode (116A, 116B, 116C, 116D,

146A, 146B, 146C, 146D, 156A, 156B), and

at least one optical element (18, 38, 88) in operative communication with the at least one light emitting diode (116A, 116B, 116C, 116D, 146A, 146B, 146C, 146D, 156A, 156B) and having a pre-defined optical prescription; and

a zoom apparatus (20, 40, 90) supporting the optical elements (18, 38, 88) of the optical sources (114A, 114B, 114C, 114D), the zoom apparatus (20, 40, 90) adjusting an axial separation between the at least one light emitting diode (116A, 116B, 116C, 116D, 146A, 146B, 146C, 146D, 156A, 156B) of each optical source (114A, 114B, 114C, 114D) and its corresponding at least one optical element (18, 38, 88).

2. The spot module as set forth in claim 1, wherein each of the plurality of optical sources (114A, 114B, 114C, 114D) produces light having selected output characteristics, the selected output characteristics differing for each of the optical light sources (114A, 114B, 114C, 114D), the spot module further including:

a control unit (130) that selectively operates a selected one or more of the optical sources (114A, 114B, 114C, 114D) to produce light having selected light output characteristics.

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3. The spot module as set forth in claim 2, wherein the selective operation of the plurality of optical sources (114A, 114B, 114C, 114D) includes at least one of:

selectively operating one of the plurality of optical sources (114A, 114B, 114C, 114D);

selectively operating a sub-set of the plurality of optical sources (114A, 114B, 114C, 114D); and

selectively operating all of the plurality of optical sources (114A, 114B, 114C, 114D).

4. The spot module as set forth in claim 1, wherein the zoom apparatus (40) includes:

two slidably interconnected sleeves (42, 44), the first sleeve (42) being connected with the at least one light emitting diode (116A, 116B, 116C, 116D, 146A, 146B, 146C, 146D, 156A, 156B) and the second sleeve (44) being connected with the at least one optical element (38).

5. The spot module as set forth in claim 1, wherein the zoom apparatus (90) includes:

two threadedly interconnected sleeves (92, 94), the first sleeve (92) being connected with the at least one light emitting diode (116A, 116B, 116C, 116D, 146A, 146B, 146C, 146D, 156A, 156B) and the second sleeve (94) being connected with the at least one optical element (88).

6. The spot module as set forth in claim 1, wherein the at least one optical element (18, 38, 88) includes a lens (18, 38, 88) corresponding to each light emitting diode (116A, 116B, 116C, 116D, 146A, 146B, 146C, 146D, 156A, 156B), the lens receiving and focusing light from the light emitting diode (116A, 116B, 116C, 116D, 146A, 146B, 146C, 146D, 156A, 156B).

7. The spot module as set forth in claim 6, wherein each light emitting diode further includes:

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an epoxy or resin encapsulant (124A, 124B, 124C, 124D) that hermetically seals the light emitting diode, the epoxy or resin encapsulant (124A, 124B, 124C, 124D) providing light refraction that cooperates with the lens (18, 38, 88) to focus the light.

8. A lamp including:

an LED module (16, 36, 86) including at least one LED (12, 32, 82) arranged on a substrate (14, 34, 84);

an optical system comprising at least one lens (18, 38, 88) in optical communication with the LED module (16, 36, 86); and

a zoom apparatus (20, 40, 90) that selectively adjusts the relative axial separation of the optical system and the LED module (16, 36, 86).

9. The lamp as set forth in claim 8, wherein the LED module (16, 36, 86) includes:

a plurality of LED's (12, 32, 82) arranged in a first pattern on the substrate (14, 34, 84).

10. The lamp as set forth in claim 9, wherein the at least one lens (18, 38, 88) includes:

a plurality of Fresnel lens arranged in a second pattern that corresponds with the first pattern.

11. The lamp as set forth in claim 9, wherein the optical system includes:

a plurality of lenses (18, 38, 88) wherein each lens is axially aligned with an LED (12, 32, 82) and optically communicates with said LED (12, 32, 82).

12. The lamp as set forth in claim 9, wherein the plurality of LEDs (12, 32, 82) of the LED module (16, 36, 86) include:

a first LED lighting unit (114A) including a plurality of first LEDs (116A, 146A, 156A) that produce light having first characteristics; and

- 20 -

a second LED lighting unit (114B) including a plurality of second LEDs (116B, 146B, 156B) that produce light having second characteristics which are different from the first characteristics;

wherein the first and second LED lighting units (114A, 114B) are selectively operated to produce light output with a selected one of the first and second characteristics.

13. The lamp as set forth in claim 8, wherein the zoom apparatus (90) includes:

a first sleeve (92) having the LED module (86) arranged thereon, the first sleeve (90) further having a first threading (96) arranged thereon; and

a second sleeve (94) having a second threading (98) arranged thereon that is adapted to cooperate with the first threading (96) such that the first sleeve (92) and the second sleeve (94) are relatively movable in a screwing fashion, the second sleeve (94) further having the optical system arranged thereon.

14. The lamp as set forth in claim 13, further including:

an index system that relatively biases the first sleeve (92) and the second sleeve (94) into one or more selectable relative axial positions.

15. The lamp as set forth in claim 8, wherein the zoom apparatus (40) includes:

a first element (42) having the LED module (36) disposed thereon; and

a second element (44) adapted to slidably connect with the first element (42), the second element (44) further having the optical system disposed thereon.

16. The lamp as set forth in claim 15 wherein the zoom apparatus (40) further includes:

a mechanical interlock (50, 52) between the first and the second elements (42, 44) that prevents relative rotation therebetween.

- 21 -

17. The lamp as set forth in claim 16, wherein the mechanical interlock (50, 52) includes:

a protrusion (50) on one of the first and the second elements (42, 44), the protrusion (50) being aligned parallel to the optical axis; and

a groove (52) on one of the first and the second elements (42, 44) that receives the protrusion (50) to prevent relative rotation of the first and the second elements (42, 44).

18. The lamp as set forth in claim 15, further including:

a stop (46) that relatively biases the first and the second elements (42, 44) into one or more selectable relative axial stop positions (48).

19. The lamp as set forth in claim 8, wherein the LED module (16) further including:

a heat sink (24) thermally connected with the substrate (14) for cooling the LED module (16).

20. A lamp including:

a substrate (112, 142, 152);

a first lighting unit (114A) comprising:

a. first light emitting diode (LED) (116A, 146A, 156A)

arranged on the substrate (112, 142, 152), and

a first lens element (124A) having a first optical prescription and being arranged to interact with light produced by the first LED (116A, 146A, 156A); and

a second lighting unit (114B) comprising:

a second light emitting diode (LED) (116B, 146B, 156B)

arranged on the substrate (112, 142, 152), and

a second lens element (124B) having a second optical prescription and being arranged to interact with light produced by the second LED (116B, 146B, 156B).

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21. The lamp as set forth in claim 20, further including:  
a control unit (130) which applies operating power to at least one of the first lighting unit (114A) and the second lighting unit (114B).
22. The lamp as set forth in claim 20, further including:  
a control unit (130) having at least two selectable operational modes including:
  - a first selectable operational mode in which power is applied to the first lighting unit (114A), and
  - a second selectable operational mode in which power is applied to the second lighting unit (114B).
23. The lamp as set forth in claim 22, wherein the control unit (130) further has:  
a third selectable operational mode in which power is applied to the first lighting unit (114A) and to the second lighting unit (114B).
24. The lamp as set forth in claim 20, wherein:
  - light emission from the first LED (116A, 146A, 156A) has a first spectral distribution; and
  - light emission from the second LED (116B, 146B, 156B) has a second spectral distribution that is different from the first spectral distribution.
25. The lamp as set forth in claim 20, wherein:  
at least one of the first lens element (124A) and the second lens element (124B) includes a tinted region whereby the spectral distribution of the light emission of the at least one lighting unit (114A, 114B) that includes the tinted region is altered in a pre-selected manner by the tinted region..
26. The lamp as set forth in claim 20, further including:

- 23 -

a mechanically movable zoom apparatus (20, 40, 90) that includes an optical system (18, 38, 88) that interacts with the first and second lighting units (114A, 114B) to produce a variable light beam spot size.

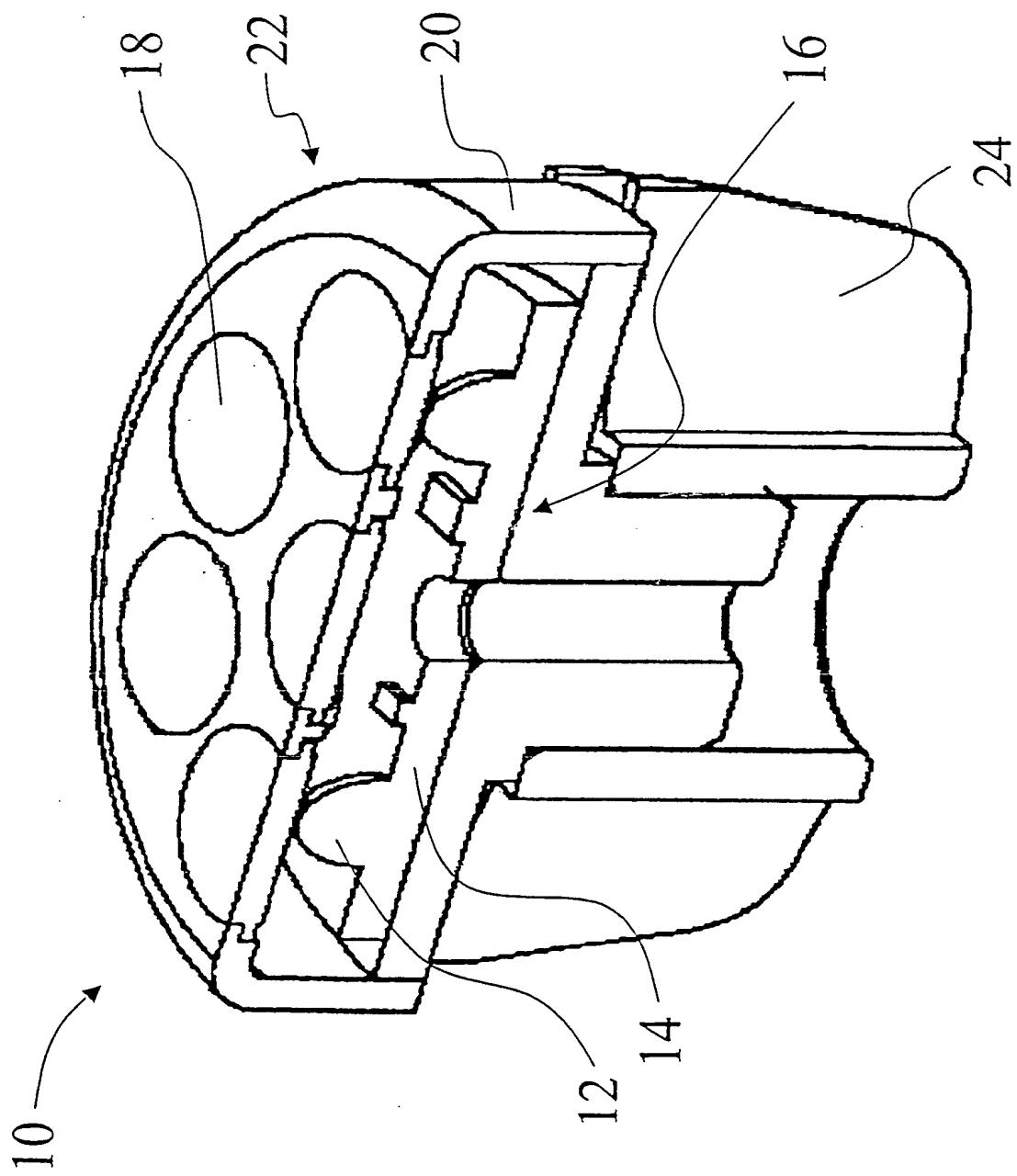


FIG 1

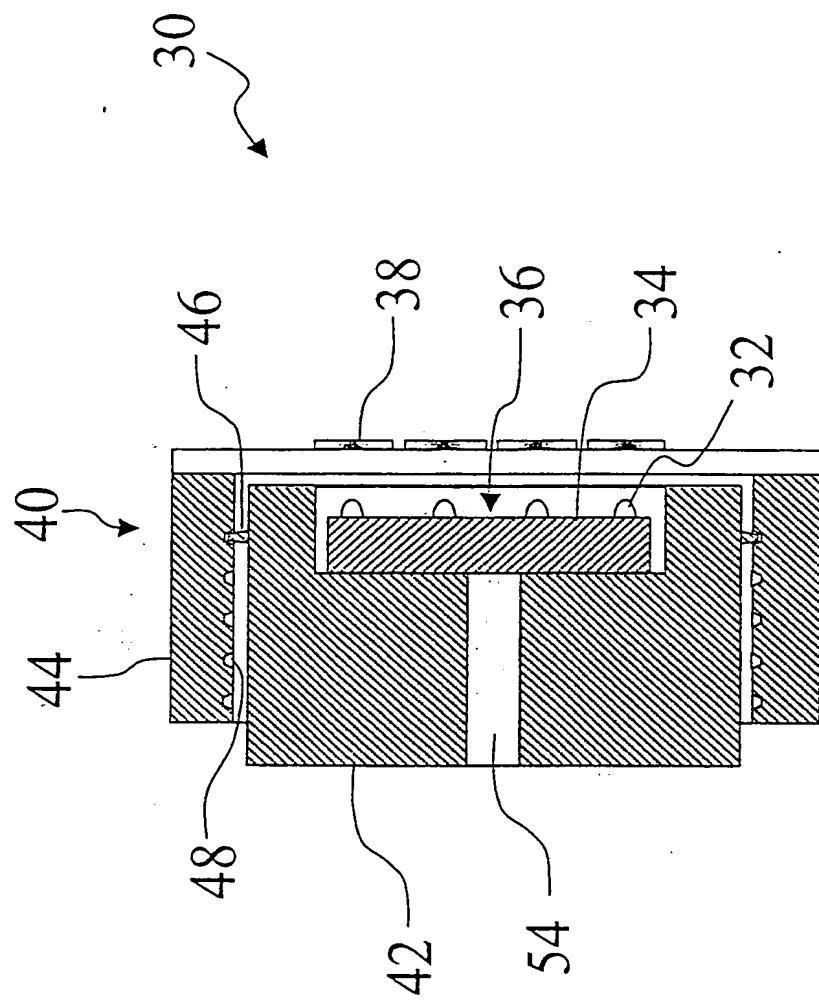


FIG 2

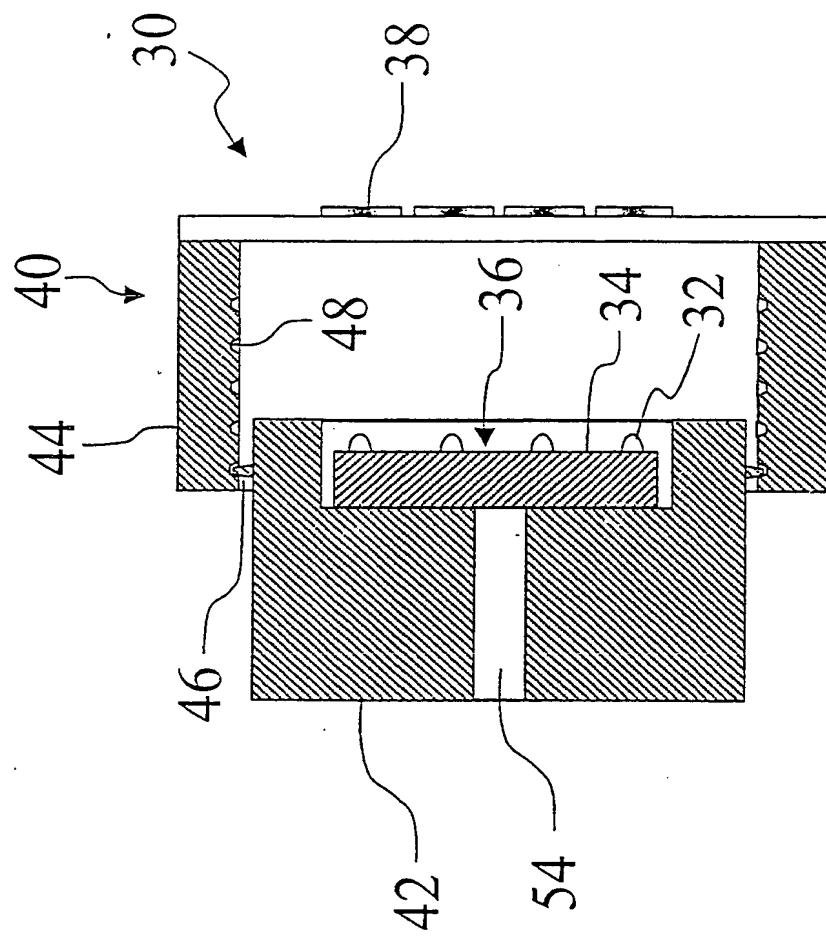
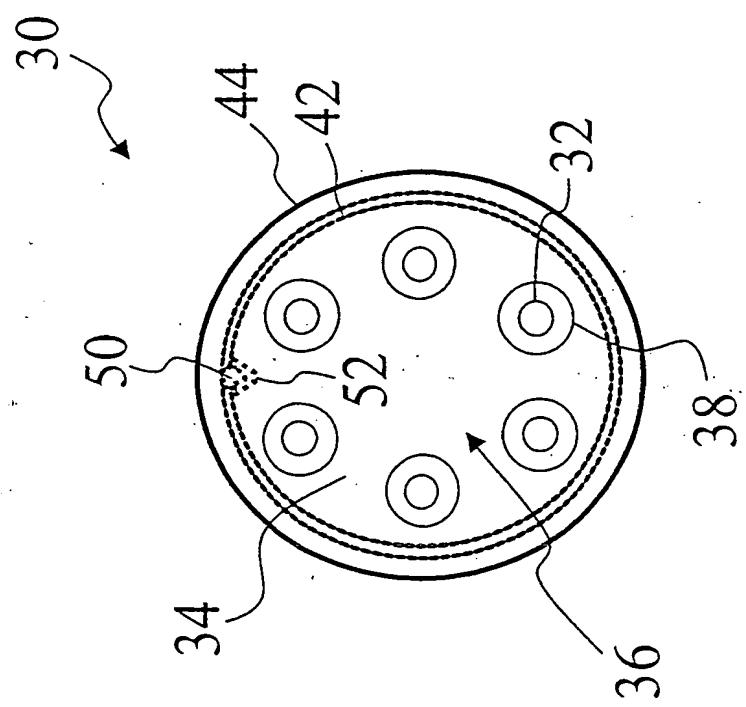


FIG 3



**FIG 4**

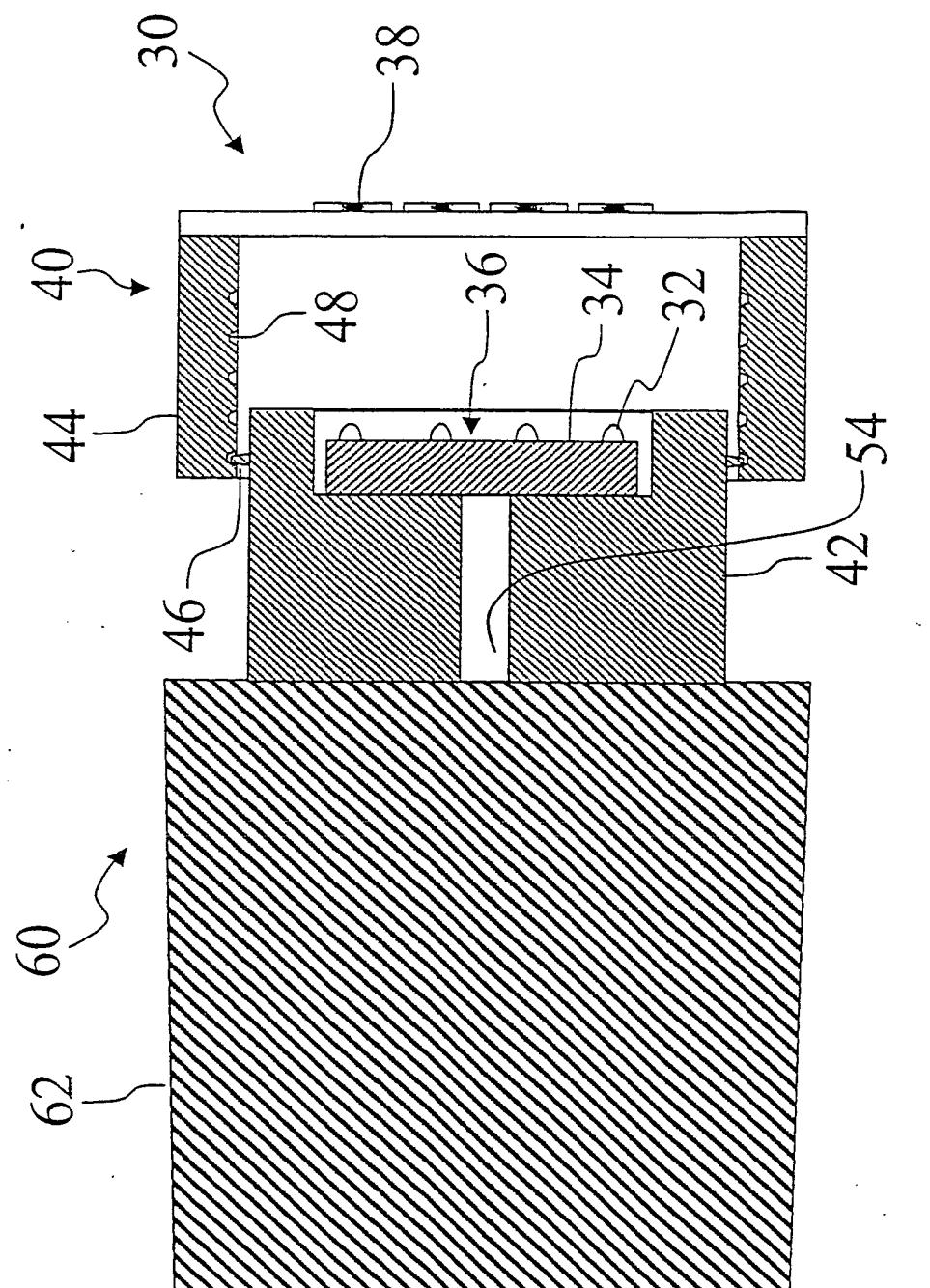


FIG 5

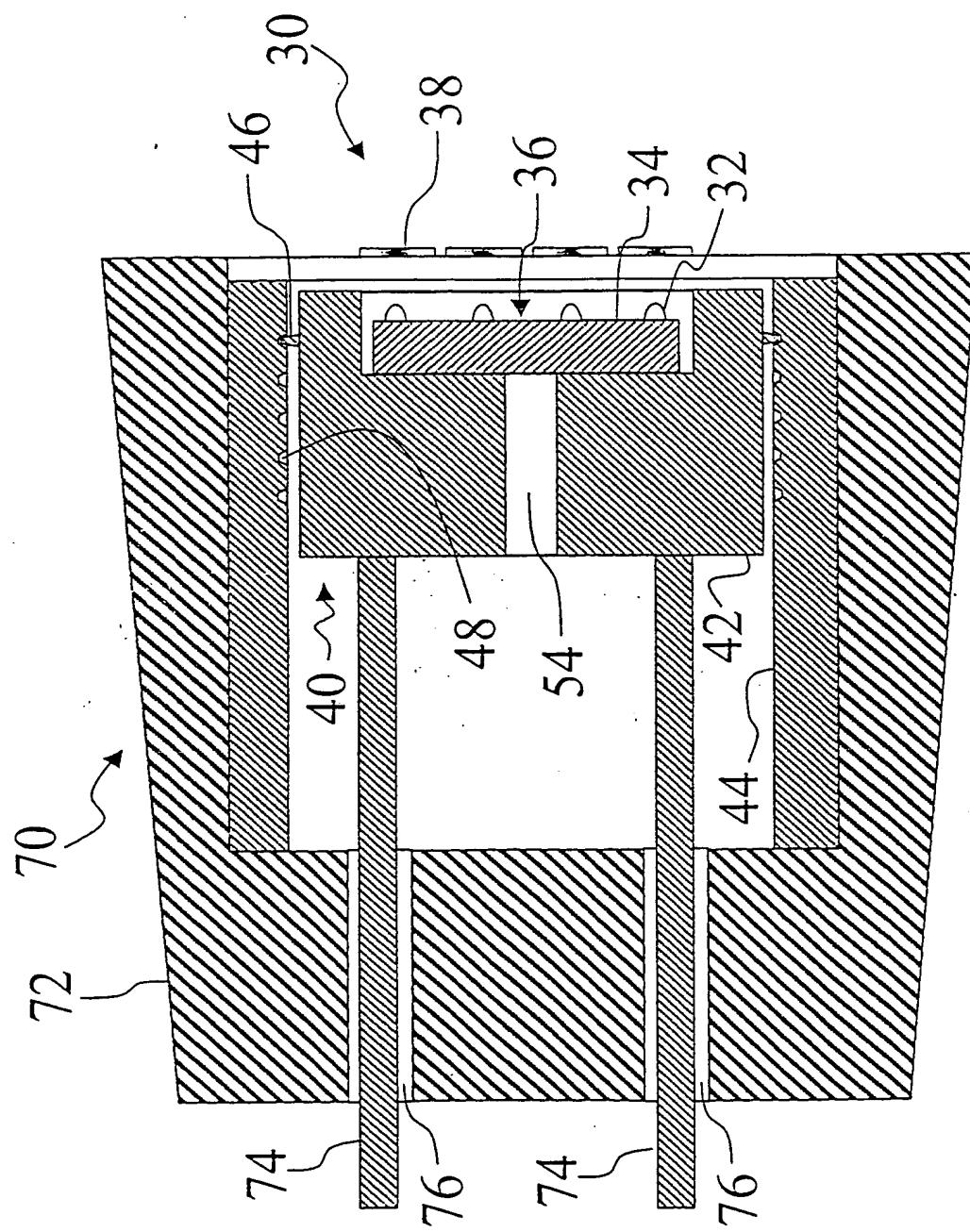


FIG 6

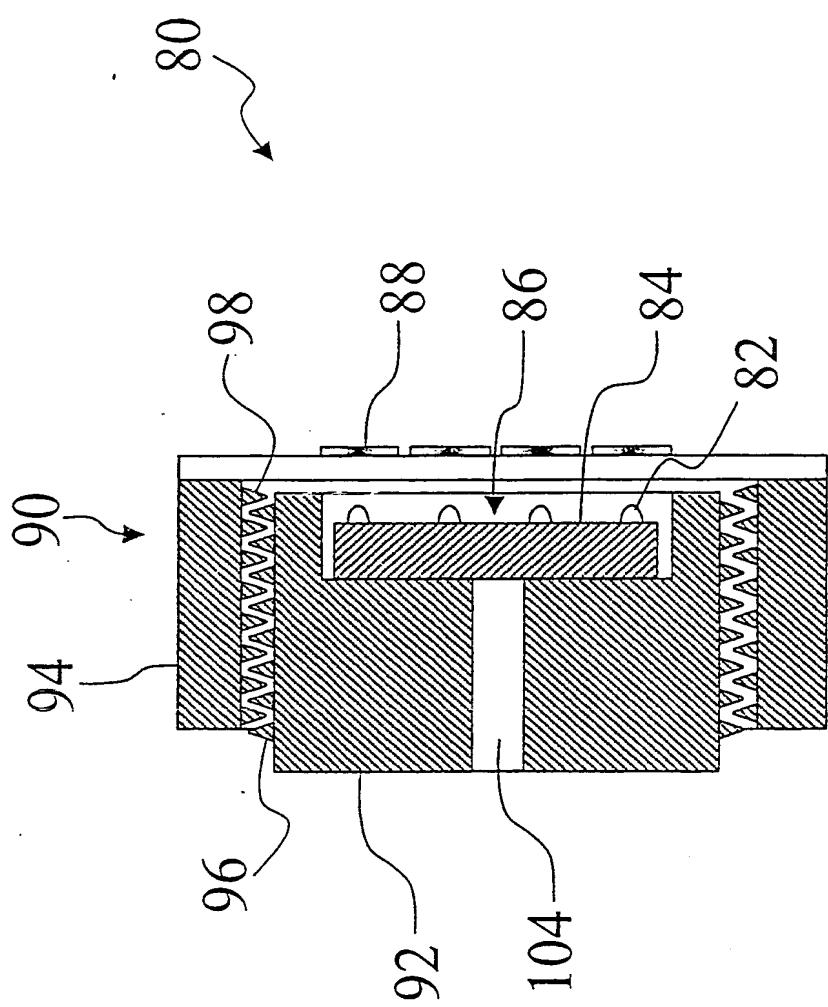
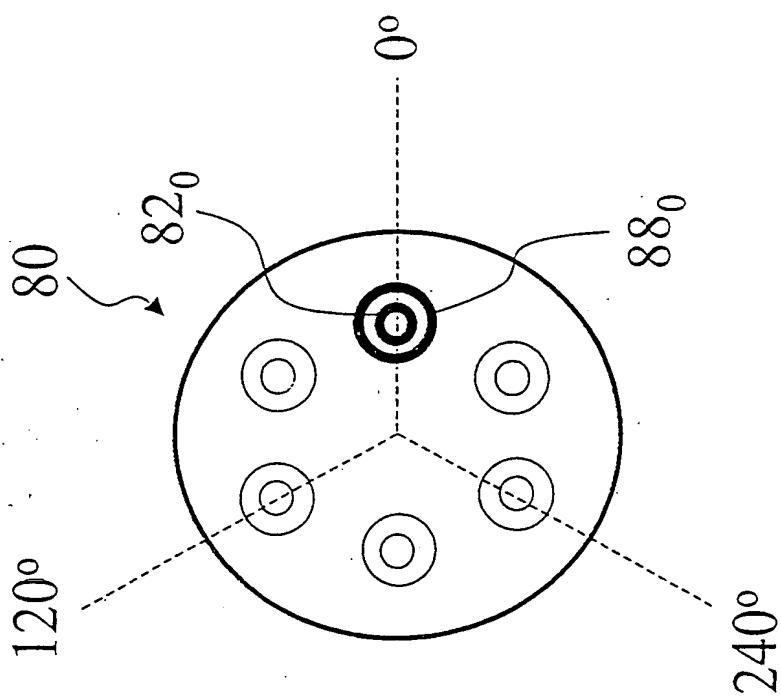


FIG 7



**FIG 8A**

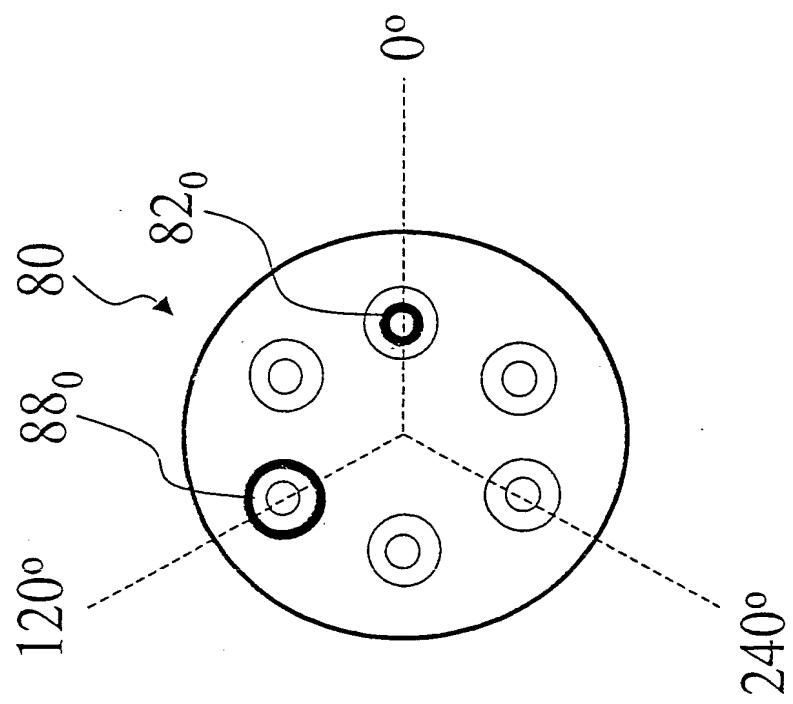


FIG 8B

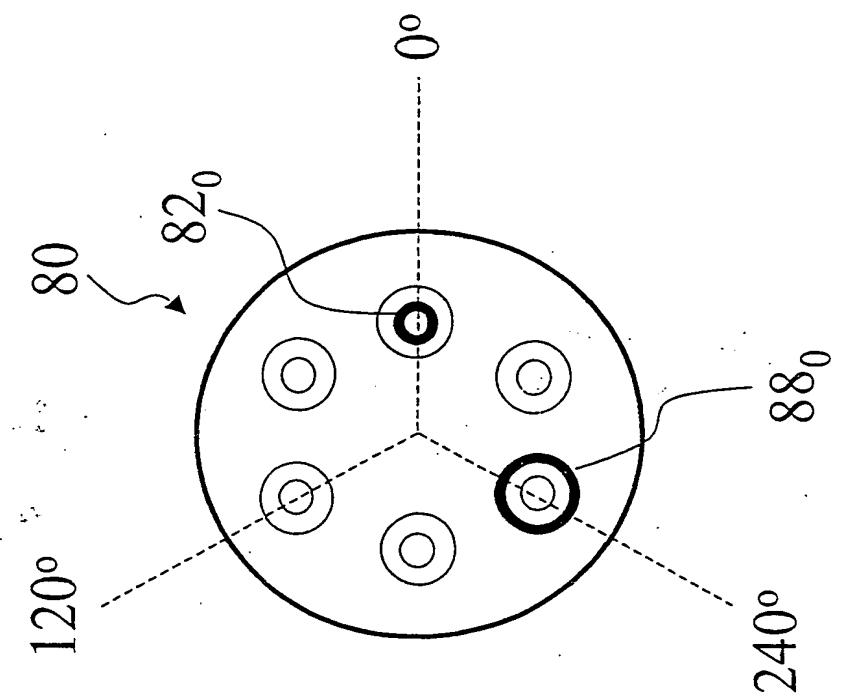


FIG 8C

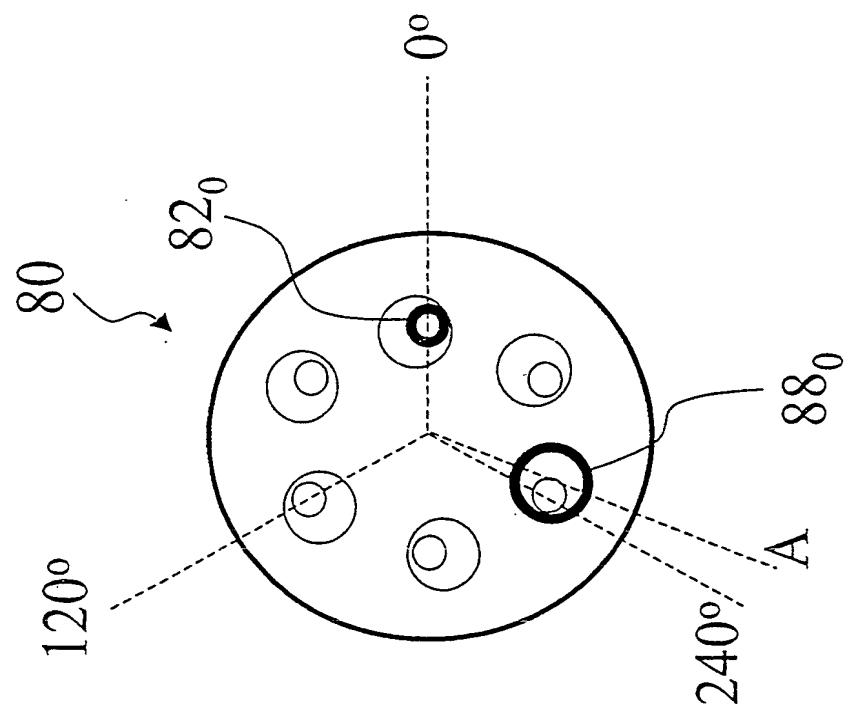


FIG 8D

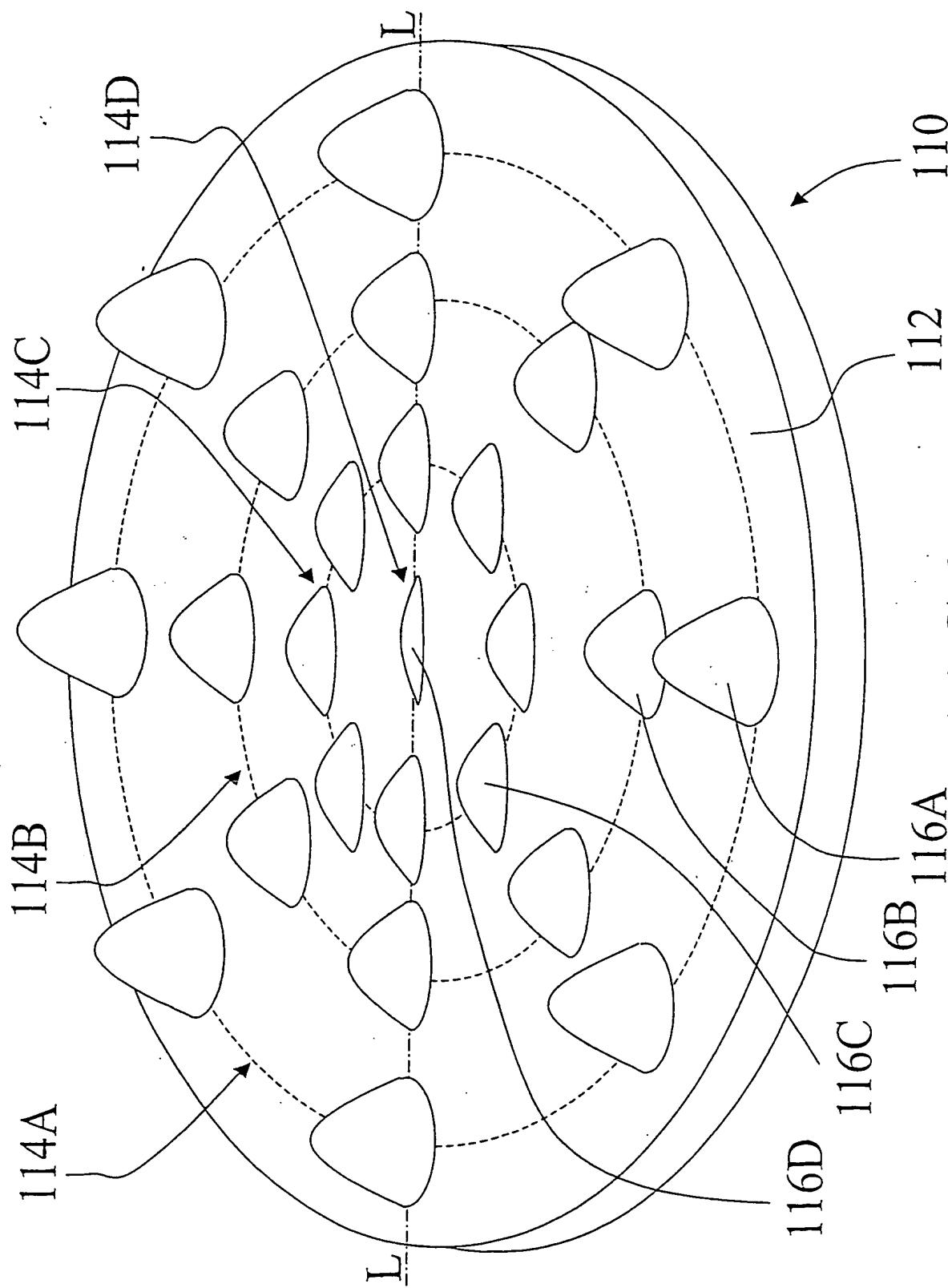


FIG 9

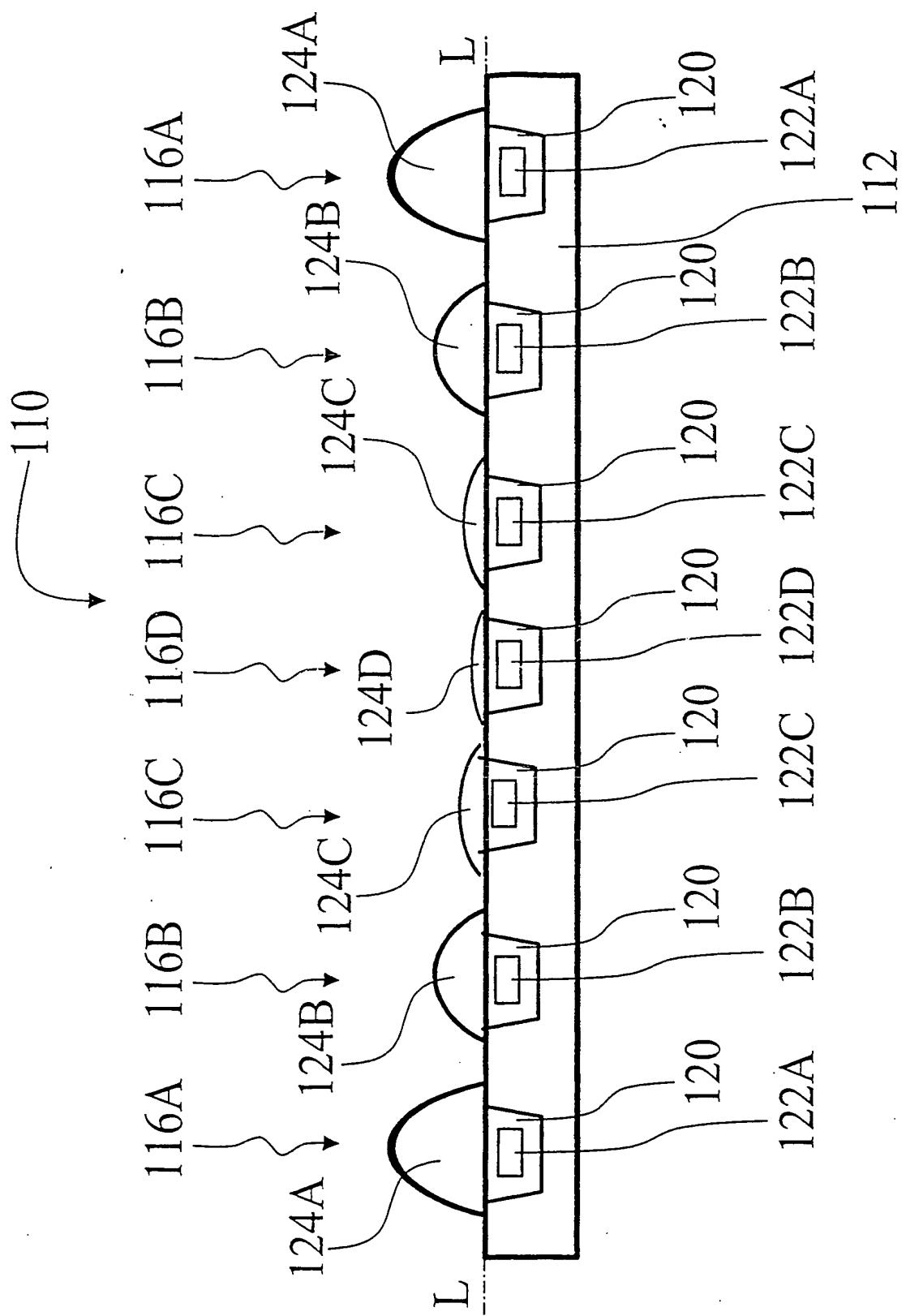


FIG 10

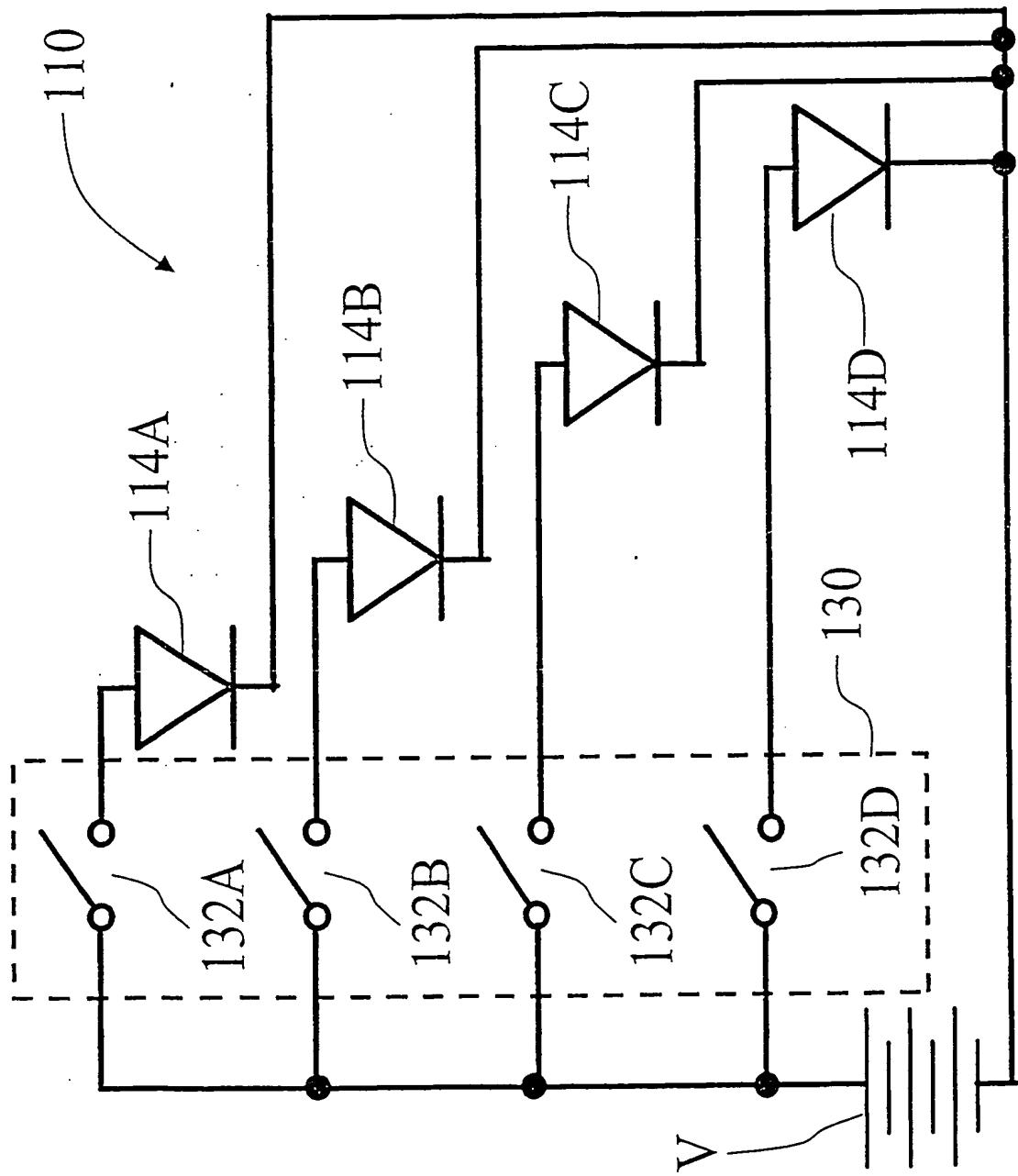
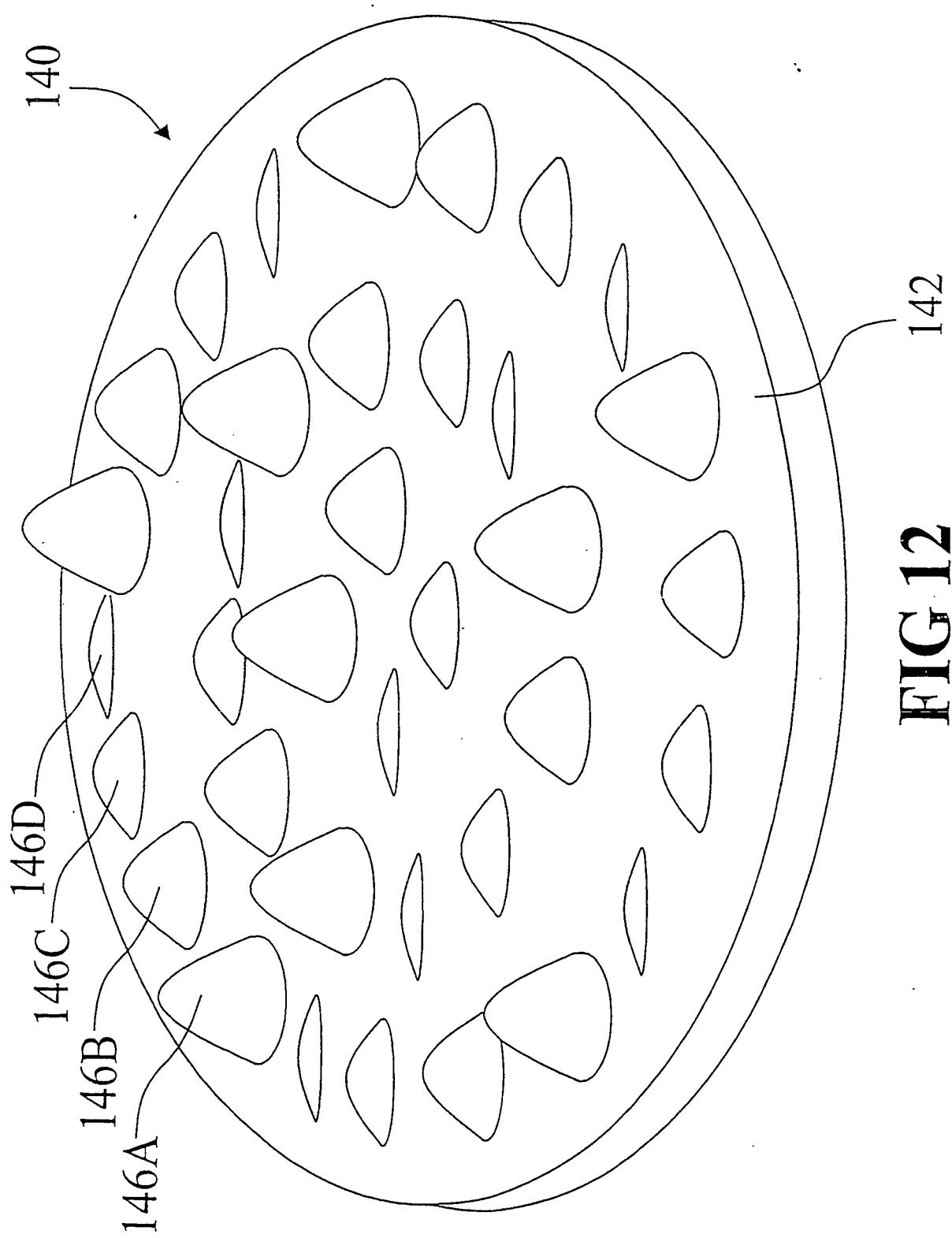


FIG 11

**FIG 12**

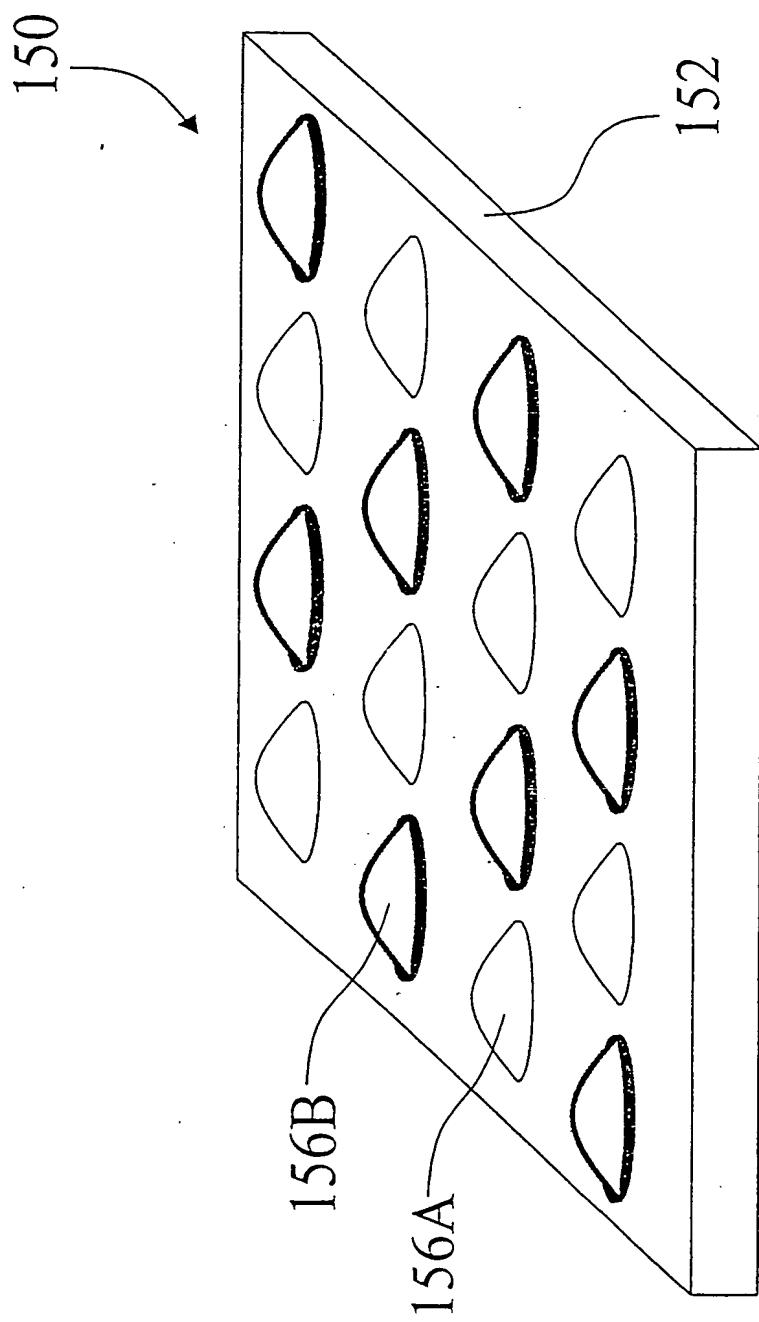


FIG 13

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 02/29561

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 7 F21V19/02 F21V14/06

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 F21V

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 072 884 A (KELLY WILLIAM M) 31 January 2001 (2001-01-31)  column 4, line 18-44 column 5, line 13-33 column 8, line 26-58 column 9, line 1-46 column 10, line 21-49 column 11, line 3-13; figures 1-6	1-3, 5-12, 19-24, 26
Y	---	16, 18
Y	US 5 580 163 A (JOHNSON II HOWARD W) 3 December 1996 (1996-12-03) column 3, line 16-67 column 4, line 14-51; figures 2-4, 6 ---	16, 18
		-/-

 Further documents are listed in the continuation of box C. Patent family members are listed in annex.

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\*&amp;\* document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 November 2002	12/12/2002
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patenlaan 2 NL 2280 HV Rijswijk Tel: (+31-70) 340-2040, Tx. 31 651 eponl, Fax: (+31-70) 340-3016	Authorized officer  Bader-Arboreanu, A

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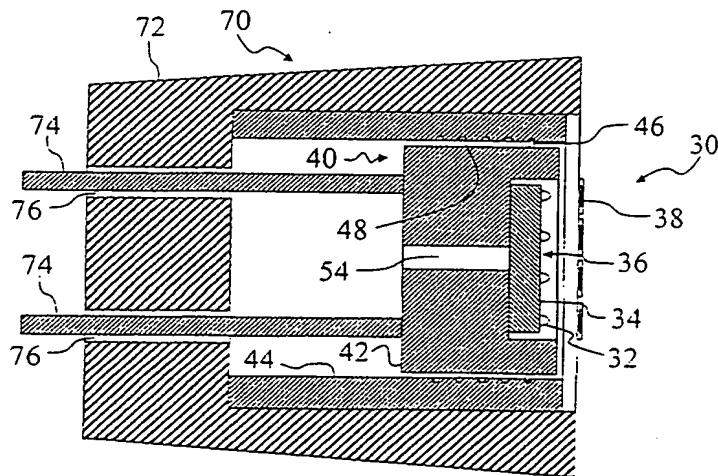
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[Continued on next page]

(54) Title: VARIABLE OPTICS SPOT MODULE



WO 03/025458 A1

(57) Abstract: A spot module that has a selectable light output includes a substrate (14, 34, 84, 112, 142, 152). A plurality of optical sources (114A, 114B, 114C, 114D) are arranged on the substrate (14, 34, 84, 112, 142, 152). Each optical source (114A, 114B, 114C, 114D) includes at least one light emitting diode (116A, 116B, 116C, 116D, 146A, 146B, 146C, 146D, 156A, 156B, 116C, 116D, 146A, 146B, 146C, 146D, 156A, 156B) and having a pre-defined optical prescription. A zoom apparatus (20, 40, 90) supports the optical elements (18, 38, 88) of the optical sources (114A, 114B, 114C, 114D). The zoom apparatus (20, 40, 90) adjusts an axial separation between the at least one light emitting diode (116A, 116B, 116C, 116D, 146A, 146B, 146C, 146D, 156A, 156B) of each optical source (114A, 114B, 114C, 114D) and its corresponding at least one optical element (18, 38, 88).



*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

## INTERNATIONAL SEARCH REPORT

International Application No  
PCT/US 02/29561

C. (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 033 087 A (KAWASHIMA TOKIO ET AL) 7 March 2000 (2000-03-07) column 3, line 24-64 column 5, line 55-67 column 6, line 1-44 -----	20

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International Application No

PCT/US 02/29561

Patent document cited in search report		Publication date		Patent family member(s)		Publication date
EP 1072884	A	31-01-2001	EP US	1072884 A2 6454437 B1	31-01-2001 24-09-2002	
US 5580163	A	03-12-1996		NONE		
US 6033087	A	07-03-2000	JP JP TW	3106986 B2 10021703 A 402856 B	06-11-2000 23-01-1998 21-08-2000	



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⑪ Publication number:

0 326 668  
A2

⑫

## EUROPEAN PATENT APPLICATION

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⑮ Int. Cl. 1: B60Q 1/26

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09.08.89 Bulletin 89/32

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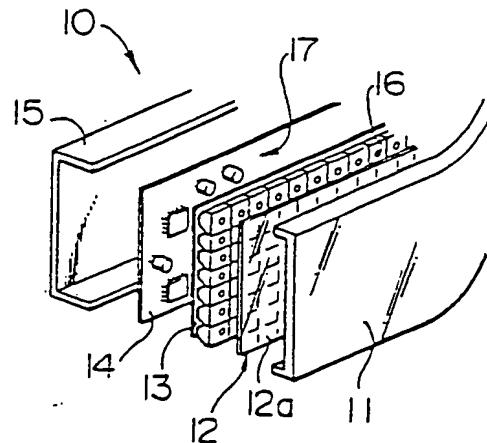
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D-4000 Düsseldorf 1(DE)

㉒ Rear combination lamp assembly for vehicles.

㉓ In a rear combination lamp assembly (10) for a vehicle, a plurality of LEDs (16) capable of being turned on and off independently of each other are mounted on a first printed circuit board (13). A plate-like lens element (12) and a second printed circuit board (14) are arranged with the first printed circuit board (13) located between them. A control circuitry (17) is mounted on the second printed circuit board (14), for selectively turning on and off the LEDs (16) to display various patterns on a matrix display (18) formed by the LEDs (16). The first printed circuit board (13), the lens element (12) and the second printed circuit board (14) are held in a united fashion.

EP 0 326 668 A2

FIG. 1



## BACKGROUND OF THE INVENTION

The present invention relates to a rear combination lamp assembly adapted to be mounted to each of the opposite sides of a rear part of a vehicle body, in particular, an automobile body, the rear combination lamp assembly having incorporated therein a tail lamp, a stop lamp, a winker lamp, a back-up lamp and the like in a united fashion.

Conventionally, a rear combination lamp assembly of the kind referred to above has incorporated therein, for example, a plurality of incandescent lamp bulbs which bear functions of various lamps. The arrangement is such that a selected one or more of the lamp bulbs is or are energized to emit light, thereby turning on, through a reflector and a lens, a corresponding one of a tail lamp section, a stop lamp section, a winker lamp section and a back-up lamp section.

As described above, the arrangement of the conventional rear combination lamp assembly is such that, in actual use, a selected one or more of the lamp bulbs is or are energized to turn on a corresponding one of the tail lamp and the like. Accordingly, the conventional rear combination lamp assembly has no great difference in function from the case where various lamps are arranged separately from each other. That is, the conventional rear combination lamp assembly merely has advantages in the design aspect. If an attempt is made to freely display various patterns such as, for example, characters, symbols and the like by the use of the conventional rear combination lamp assembly, it is necessary to prepare light sources in number required to display the pattern. If incandescent lamp bulbs are employed as the light sources, such problems arise that the speed of response is slow, and rush current passes through the lamp bulbs.

## SUMMARY OF THE INVENTION

It is therefore an object of the invention to provide a rear combination lamp assembly for a vehicle, in which the entire rear combination lamp assembly is utilized to enable various patterns to be displayed freely.

According to the invention, there is provided a rear combination lamp assembly for a vehicle, comprising: a first-printed circuit board having mounted thereon a plurality of LEDs capable of being turned on and

off independently of each other, the LEDs cooperating with each other to form a matrix display; a plate-like lens element arranged substantially in parallel relation to the first printed circuit board and in front of the same to cover the LEDs; a second printed circuit board arranged on the opposite side of the first printed circuit board from the lens element and substantially in parallel relation to the first printed circuit board, the second printed circuit board having mounted thereon control circuit means for selectively turning on and off the LEDs to display various patterns on the matrix display; and holding means for holding the first printed circuit board, the lens element and the second printed circuit board in a united fashion.

Since the rear combination lamp assembly according to the invention employs the LEDs as light sources, the rear combination lamp assembly has such advantages that the service life is long, the speed of response when turned on is fast, no rush current flows, and the construction is made compact. The rear combination lamp assembly is also superior in vibration resistance and shock resistance. Further, selective energization and deenergization of the LEDs by means of the control circuit means enable desirable patterns to be displayed on the matrix display. The desirable patterns may, for example, include a pattern in which a light-emitting region on the matrix display continuously varies in area depending upon an amount of depression of a brake pedal, a sequential display pattern in which, at winker display, a light-emitting region moves with the lapse of time in the direction indicated, and a pattern formed by characters or symbols in dependence upon circumstances. Thus, the rear combination lamp assembly according to the invention is high in visibility as compared with the conventional one which is merely turned on and off. Moreover, the rear combination lamp assembly according to the invention can exactly transmit information including the running conditions of the vehicle, the driver's intention, his messages and the like, to a driver in the succeeding vehicle.

## BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a fragmental perspective view of a rear combination lamp assembly for a vehicle, according to an embodiment of the invention;

Fig. 2 is a fragmental cross-sectional view showing the relationship between an inner lens element and LEDs;

Fig. 3 is an enlarged cross-sectional view of one of reflectors for the respective LEDs shown in Fig. 2;

Fig. 4 is a block diagram showing a constructional example of a control circuitry in the embodiment illustrated in Fig. 1;

Figs. 5a and 5b are views showing an example of a pattern displayed on a matrix display by means of the control circuitry illustrated in Fig. 4, when a brake pedal is depressed;

Fig. 6 is a view similar to Fig. 5b, but showing a sequential display pattern at winker display;

Fig. 7 is a view showing characters displayed on the matrix display at depression of the brake pedal; and

Fig. 8 is a view similar to Fig. 7, but showing a pattern displayed in a negative manner.

#### DETAILED DESCRIPTION

Referring to Fig. 1, there is shown an embodiment of a rear combination lamp assembly according to the invention, which is generally designated by the reference numeral 10. The rear combination lamp assembly 10 comprises a front cover 11 through which light can be transmitted and which forms a front face of the rear combination lamp assembly 10. A plate-like inner lens element 12 is arranged in rear of the front cover 11. The inner lens element 12 extends along the back side of the front cover 11 substantially in parallel relation thereto. A first printed circuit board 13 is arranged in rear of the inner lens element and extends along the back side thereof substantially in parallel relation to the inner lens element 12. A second printed circuit board 14 is arranged in rear of the first printed circuit board 13 substantially in parallel relation thereto. A rear cover 15 cooperates with the front cover 11 to form means for holding the inner lens element 12 and the first and second printed circuit boards 13 and 14, in a united fashion. That is, the rear and front covers 15 and 11 cooperate with each other to form a housing in which the components 12, 13 and 14 are accommodated.

The first printed circuit board 13 has mounted thereon a plurality of LEDs (light emitting diodes) 16 which are capable of being turned on and off independently of each other. The LEDs 16 are arranged in a regular fashion to form a matrix display 18 (see Fig. 4). The first printed circuit board 13 has also mounted thereto a plurality of tubular reflectors 16a each of which is arranged to

surround a corresponding one of the LEDs 16 to direct light emitted from the LED 16 toward the inner lens element 12 substantially perpendicularly thereto, as indicated by the broken arrows in Fig. 2. Specifically, as shown in Fig. 3, each reflector 16a is formed of transparent synthetic resinous material, and is composed generally of a wall section 16a<sub>1</sub> having a rectangular or square cross-sectional shape and a wall section 16a<sub>2</sub> having a cross-sectional shape of a frustum of quadrangular pyramid. An angle of an outer peripheral surface of each of the wall sections 16a<sub>1</sub> and 16a<sub>2</sub> with respect to the LED 16 is so determined that the light from the LED 16 is total-reflected by the outer peripheral surface of the wall section 16a<sub>1</sub>. Thus, the outer peripheral surface of the wall section 16a<sub>1</sub> serves to reflect light from the LED 16, thereby preventing the light from interfering with lights emitted from the adjacent respective LEDs surrounding the LEDs 16 in question. On the other hand, the outer peripheral surface of the wall section 16a<sub>2</sub> serves to reflect the light from the LED 16 toward the inner lens element 12 (see Fig. 2) substantially perpendicularly thereto. Referring back to Fig. 2, the reflectors 16a are arranged in close relation to each other without a substantial gap left between each pair of adjacent reflectors 16a. Thus, if the entire LEDs 16 are turned on to emit their respective lights, the rear combination lamp assembly 10 can be viewed as a plane light source.

The second printed circuit board 14 has mounted thereon a control circuitry 17 for selectively turning on and off the LEDs 16 on the first printed circuit board 13.

As shown in Fig. 2, the inner lens element 12 is formed on its back side with a plurality of lens sections 12a which are arranged in facing relation to the respective LEDs 16 mounted on the first printed circuit board 13, that is, to the respective reflectors 16a for the LEDs 16. The light emitted from each of the LEDs 16 is reflected by a corresponding one of the reflectors 16a and is guided by the same in the direction indicated by the arrows in Fig. 2. The light is dispersed by a corresponding one of the lens sections 12a of the inner lens element 12 such that the dispersed light has a suitable luminous intensity characteristic.

The control circuitry 17 mounted on the second printed circuit board 14 is constructed, for example, as shown in Fig. 4. That is, the control circuitry 17 is composed of a drive circuit 19 for driving the matrix display 18 formed by the LEDs 16, and a microcomputer 20 for suitably controlling the drive circuit 19. The microcomputer 20 includes an input port 24 and a CPU (central processing unit) 25 to which signals are inputted from a brake pedal 21, a hazard switch 22, a winker switch 23 and the like.

through the input port 24. The microcomputer 20 also includes a pattern generator 26 having beforehand stored therein various patterns. The pattern generator 26 is adapted to output a display pattern signal in response to a command signal from the CPU 25. A signal from the CPU 25 is outputted through an output port 27.

The operation of the rear combination lamp assembly constructed as above will be described below.

As a signal is inputted into the microcomputer 20 of the control circuitry 17 in response to depression of the brake pedal 21, or in response to operation of the hazard switch 22, the winker switch 23 or the like, the CPU 25 reads out a display pattern signal in accordance with the inputted signal, from the pattern generator 26, and outputs the display pattern signal to the drive circuit 19. On the basis of the display pattern signal from the CPU 25, the drive circuit 19 selectively turns on and off the LEDs 16 forming the matrix display 18.

As the selected LEDs 16 are turned on by the drive circuit 19, the light from each of the LEDs 16 is brought to a substantially parallel light under the action of a corresponding one of the reflectors 16a, and is guided toward a corresponding one of the lens sections 12a of the inner lens element 12. The light is dispersed by the corresponding lens section 12a so as to have a suitable luminous intensity characteristic, and is emitted outwardly through the front cover 11.

In case of depression of the brake pedal 21, the following pattern is displayed on the matrix display 18. That is, as shown in Fig. 5a, an amount of depression of the brake pedal 21 is relatively small, a central region of the matrix display 18 first emits light as shown in Fig. 5b. As the amount of depression of the brake pedal 21 increases, the light-emitting region on the matrix display 18 increases in area and spreads out toward the periphery of the matrix display 18. In case of operation of the winker switch 23, a so-called sequential display can be done, as shown in Fig. 6, in which light-emitting regions on the matrix display 18 move with the lapse of time in the right-hand direction in the rear combination lamp assembly 10 on the right-hand side, for example. Thus, it is possible for the rear combination lamp assembly 10 to realize the winker display high in visibility as compared with the conventional one which is merely turned on and off.

Moreover, it is possible to display characters or symbols on the matrix display 18. For example, when the brake pedal 21 is depressed, the characters "STOP" can be displayed on the matrix display 18 as shown in Fig. 7. When the hazard switch 22 is operated, the characters "HAZARD" or "HELP" can be displayed on the matrix display 18.

When the winker switch 23 is operated, the characters "LEFT" or "RIGHT", or a symbol like that shown in Fig. 6 can be displayed on the matrix display 18. Further, when it is desired that the rear combination lamp assembly 10 functions as a tail lamp, any pattern such as a name or the like may be displayed on the matrix display 18. Additionally, when the pattern display such as the characters, the symbols and the like is done, the pattern can be displayed in a positive manner in which only ones of the LEDs 16 corresponding to the pattern are turned on, as shown, for example, in Fig. 7. Alternatively, the pattern can be displayed in a negative manner in which only ones of the LEDs 16 corresponding to the pattern are turned off as shown in Fig. 8.

As described above, according to the invention, it is possible not only that various lamp sections are merely turned on and off, but also that the entire rear combination lamp assembly is utilized to freely display various patterns. Further, the rear combination lamp assembly is extremely long in service life and fast in speed of response. Moreover, the rear combination lamp assembly can be made compact in structure.

### Claims

1. A rear combination lamp assembly for a vehicle, characterized by comprising:  
a first printed circuit board (13) having mounted thereon a plurality of LEDs (16) capable of being turned on and off independently of each other, said LEDs (16) cooperating with each other to form a matrix display (18);  
a plate-like lens element (12) arranged substantially in parallel relation to said first printed circuit board (13) and in front of the same to cover said LEDs (16);  
a second printed circuit board (14) arranged on the opposite side of said first printed circuit board (13) from said lens element (12) and substantially in parallel relation to said first printed circuit board (13), said second printed circuit board (14) having mounted thereon control circuit means (17) for selectively turning on and off said LEDs (16) to display various patterns on said matrix display (18); and  
holding means (11, 15) for holding said first printed circuit board (13), said lens element (12) and said second printed circuit board (14) in a united fashion.

2. A rear combination lamp assembly according to claim 1, characterized in that said lens element (12) has a plurality of lens sections (12a) corresponding respectively to said LEDs (16), each

of said lens sections (12a) being adapted to disperse light from a corresponding one of said LEDs (16) substantially uniformly.

3. A rear combination lamp assembly according to claim 1 or 2, characterized in that said holding means comprises a rear cover (15) and a front cover (11) through which lights from the respective LEDs (16) can be transmitted, said rear cover (15) and said front cover (11) cooperating with each other to form a housing in which said first printed circuit board (13), said lens element (12) and said second printed circuit board (14) are accommodated.

4. A rear combination lamp assembly according to one of the claims 1 to 3, characterized in that said first printed circuit board (13) has mounted thereto a plurality of tubular reflectors (16a), each of said tubular reflectors (16a) being arranged to surround a corresponding one of said LEDs (16) to direct the light from the corresponding LED toward said lens element (12) substantially perpendicularly thereto and to prevent the light from the corresponding LED from interfering with the lights from the adjacent respective LEDs.

5. A rear combination lamp assembly according to claim 4, characterized in that each of said tubular reflectors (16a) has a rectangular cross-sectional shape, said tubular reflectors (16a) being arranged in close relation to each other without a substantial gap left between each pair of adjacent reflectors.

6. A rear combination lamp assembly according to claim 5, characterized in that each of said tubular reflectors (16a) has a generally square cross-sectional shape.

7. A rear combination lamp assembly according to one of the claims 1 to 6, characterized in that said LEDs (16) are arranged regularly on said first printed circuit board (13).

8. A rear combination lamp assembly according to one of the claims 1 to 7, characterized in that said control circuit means (17) comprises a memory means (26) having stored therein said various patterns and means (25) for reading out a selected one of said various patterns to display the selected pattern on said matrix display (18).

9. A rear combination lamp assembly according to claim 8, characterized in that said memory means comprises a pattern generator (26).

10. A rear combination lamp assembly according to one of the claims 1 to 9, characterized in that said various patterns include a pattern in which a light-emitting region on said matrix display (18) continuously varies in area.

11. A rear combination lamp assembly according to one of the claims 1 to 10, characterized in that said various patterns include a sequential pattern in which a light-emitting region on said matrix display (18) moves with the lapse of time.

12. A rear combination lamp assembly according to one of the claims 1 to 11, characterized in that said various patterns include a pattern formed by characters.

13. A rear combination lamp assembly according to one of the claims 1 to 12, characterized in that said various patterns include a pattern formed by symbols.

14. A rear combination lamp assembly according to one of the claims 1 to 13, characterized in that said various patterns include a positive pattern formed by ones of said LEDs (16) which are turned on.

15. A rear combination lamp assembly according to one of the claims 1 to 14, characterized in that said various patterns include a negative pattern formed by ones of said LEDs (16) which are turned off.

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FIG. 1

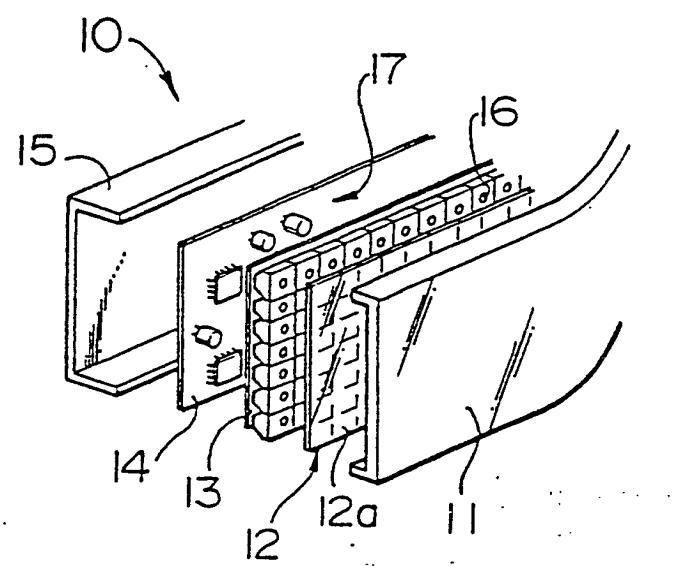


FIG. 2

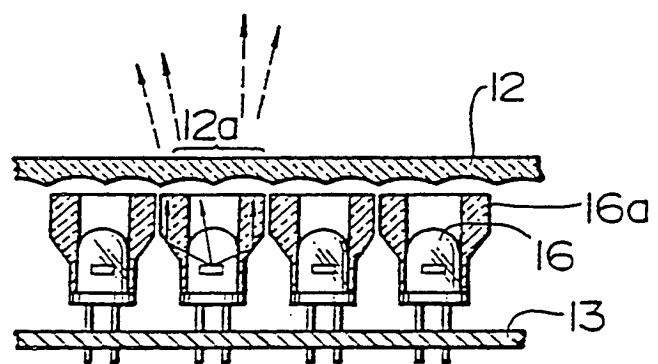


FIG. 3

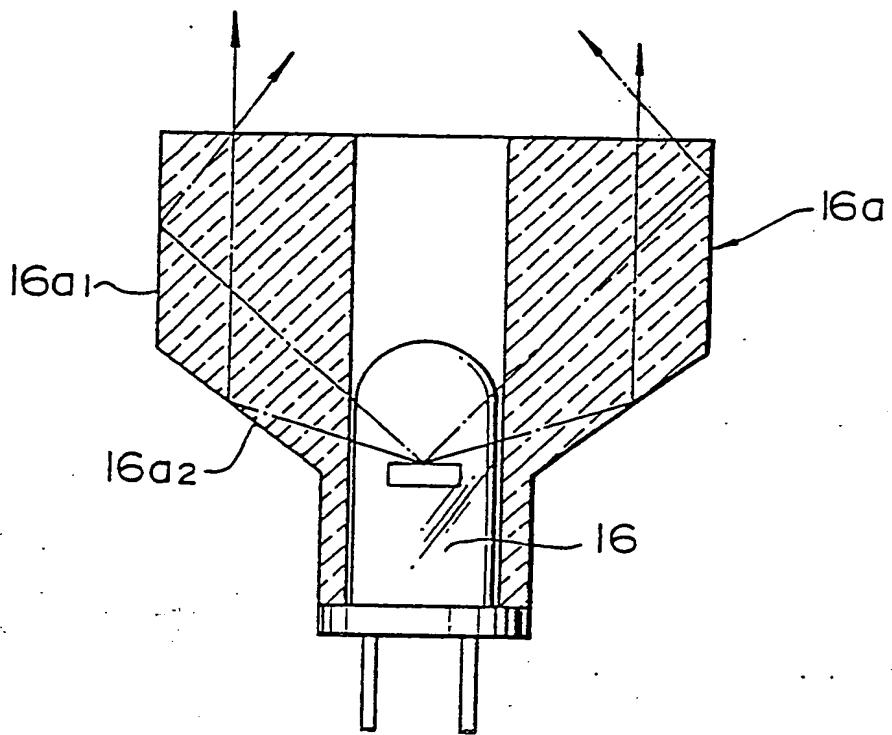
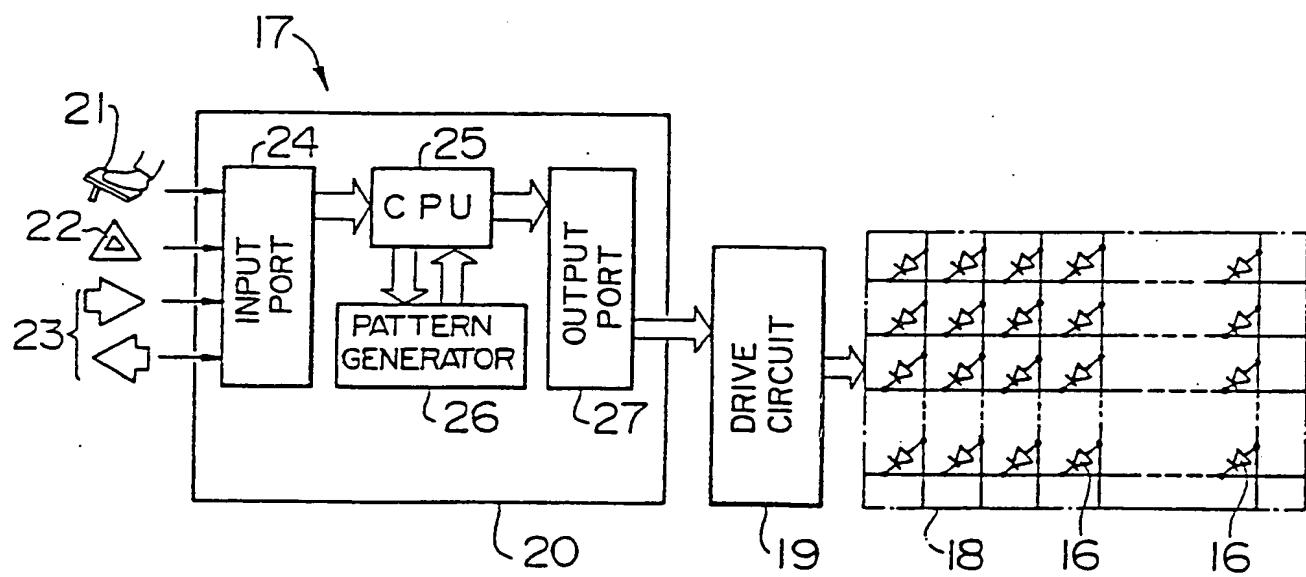
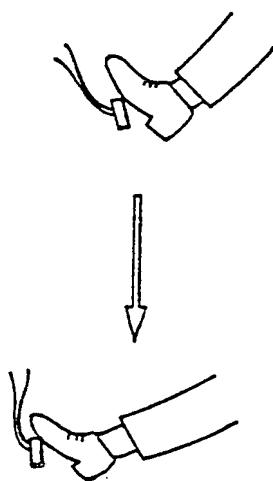


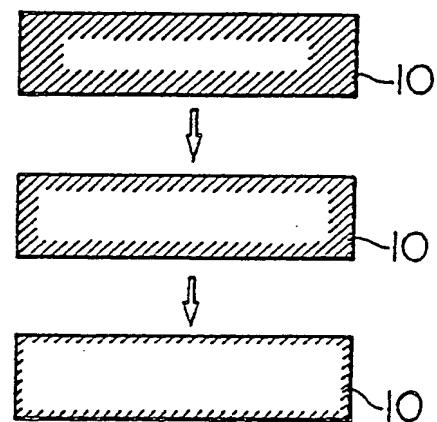
FIG. 4



**FIG. 5a**



**FIG. 5b**



**FIG. 6**

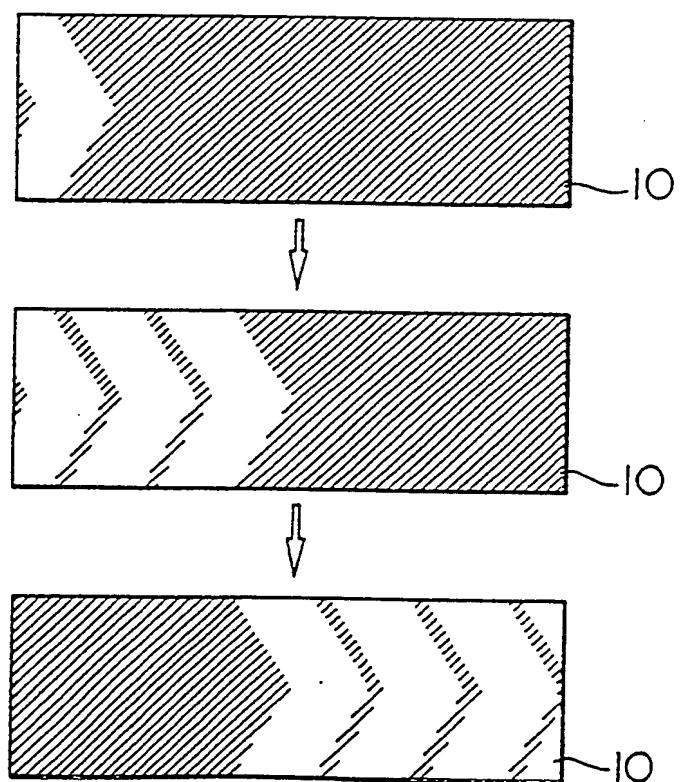


FIG. 7

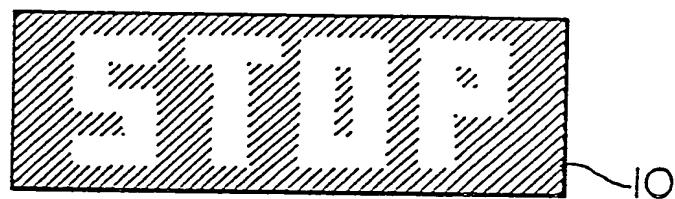
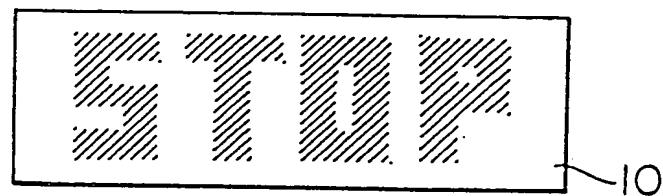


FIG. 8







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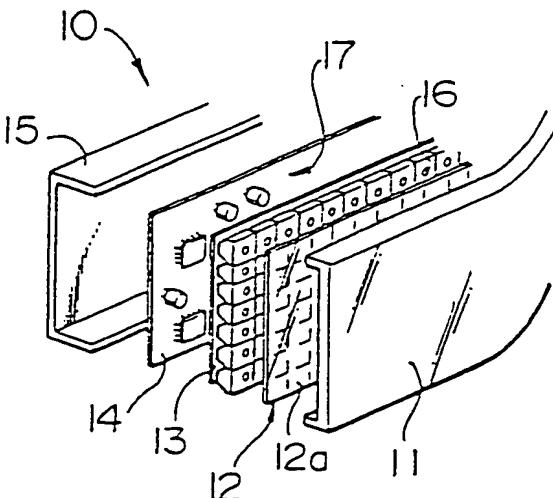
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㉓ Rear combination lamp assembly for vehicles.

㉔ In a rear combination lamp assembly (10) for a vehicle, a plurality of LEDs (16) capable of being turned on and off independently of each other are mounted on a first printed circuit board (13). A plate-like lens element (12) and a second printed circuit board (14) are arranged with the first printed circuit board (13) located between them. A control circuitry (17) is mounted on the second printed circuit board (14), for selectively turning on and off the LEDs (16) to display various patterns on a matrix display (18) formed by the LEDs (16). The first printed circuit board (13), the lens element (12) and the second printed circuit board (14) are held in a united fashion.

FIG. 1



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DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Y	GB-A-2139340 (ROBERT BOSCH GMBH) * page 3, lines 21 - 34; figure 4 *	1	B60Q1/26
A	---	2	
Y	PATENT ABSTRACTS OF JAPAN vol. 9, no. 306 (M-435)(2030) 04 December 1985, & JP-A-60 143150 (KOITO SEISAKUSHO KK) 29 July 1985, * the whole document *	1	
A	---	8-15	
P, A	US-A-4733335 (KOITO MANUFACTURING CO) * abstract; figures 1, 2, 4, 7, 11 *	1, 2, 4-7	
A	EP-A-202335 (JAPAN TRAFFIC MANAGEMENT TECHNOLOGY ASSOCIATION) * figures 3, 4 *	1, 2	
			TECHNICAL FIELDS SEARCHED (Int. Cl.4)
			B60Q B62J F21Q
The present search report has been drawn up for all claims			
1	Place of search THE HAGUE	Date of completion of the search 12 JUNE 1990	Examiner ONILLON C.G.A.
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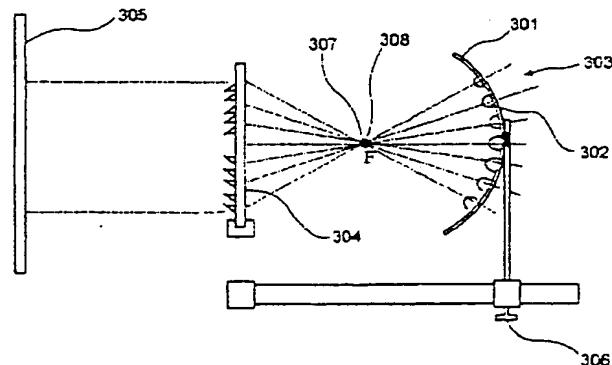
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(54)【発明の名称】 スポットライト及び光源ユニット

(57)【要約】

【課題】 フィラメントをできるだけ高温に熱して光を発生させる電球を单一光源として使用しているスポットライトの各種の問題を、多数の自発光型固体素子を光源することで解決しうるスポットライト及びその用途に適した光源ユニットを提供すること。

【解決手段】 曲面に多数の自発光型固体素子を光源として配置し、各光源の照射ビームを一点に集光させて仮想の単一点光源ユニットを構成し、この光源ユニットと投射レンズとの位置関係を可変にしたことにより、被照射面の照度及び照度分布を変化しうるスポットライトを実現した。



## 【特許請求の範囲】

【請求項1】 光源ユニットと、前記光源ユニットの光の射出方向に設けた投射レンズと、前記光源ユニットを前記投射レンズに対し光の主軸に沿っての相対的な移動及び所望位置での固定をなしうる手段とを備えたスポットライトにおいて、  
前記光線ユニットは、指向性が狭角である自発光型固体素子を複数個、曲面上に並設して各々の自発光型固体素子の照射ビームを前方の一点に集光させるように配置することにより、仮想の单一点光源を構成したことを特徴とするスポットライト。

【請求項2】 前記移動及び固定をなしうる手段により前記光源ユニットと前記投射レンズの相対的位置関係を変化させることにより、被照射面の光の照度分布が選択的に拡散又は収束するように調整できることを特徴とする請求項1に記載のスポットライト。

【請求項3】 前記投射レンズが平凸レンズ又はフレネルレンズであることを特徴とする請求項1又は2に記載のスポットライト。

【請求項4】 前記光源ユニットと平凸レンズ又はフレネルレンズの相対的位置関係を変化させる方法として、前記光源ユニットを固定し、前記平凸レンズ又はフレネルレンズを収容するハウジング部の位置を相対的に変化させる手段を備えたことを特徴とする請求項1、2又は3に記載のスポットライト。

【請求項5】 光源ユニットと、前記光源ユニットの光の射出方向に設けた投射レンズと、前記光源ユニットを前記投射レンズに対し光の主軸に沿っての相対的な移動及び所望位置での固定をなしうる手段とを備えたスポットライトにおいて、

前記光源ユニットの自発光型固体素子を発光スペクトルによりグループ化し、グループ毎に点灯又は消灯できる色温度切替えスイッチと、前記光源ユニットが作り出す仮想の单一点光源位置に設けたビーム整形ディフューザーと、前記ビーム整形ディフューザーを通過した光の射出方向に設けた投射レンズと、前記光源ユニットと前記ビーム整形ディフューザーとを一体的に固定した基台と、前記基台を光の主軸に沿って移動させるハンドル手段を備えたことを特徴とするスポットライト。

【請求項6】 前記色温度切替えスイッチにより、発光スペクトル毎にグループ化された自発光型固体素子の点灯、消灯制御を行って自発光型固体素子よりの合成発光スペクトルを調整して被照射面の色温度を切替えることができることと、前記ハンドル手段により、前記光源ユニットと前記ディフューザーとを一体的に固定した基台と平凸レンズ又はフレネルレンズの相対的位置関係を変化させることにより、被照射面の光のむらをなくして光の照度分布が選択的に拡散又は収束できるに調整できるようにしたことを特徴とする請求項5に記載のスポットライト。

【請求項7】 指向性が狭角である自発光型固体素子を複数個、曲面上に並設して各々の自発光型固体素子の照射ビームを前方の一点に集光させるように配置することにより、仮想の单一点光源を構成した光源ユニット。

【請求項8】 光源ユニットと、前記光源ユニットの光の射出方向に設けた投射レンズと、前記光源ユニットを前記投射レンズに対し光の主軸に沿っての相対的な移動及び所望位置での固定をなしうる手段とを備えたスポットライトにおいて、

前記光線ユニットは、ひとつのフレキシブルな構造の電界固体面状発光素子を曲面構造にし、電界固体面状発光素子の照射ビームを前方の一点に集光させることにより、仮想の单一点光源を構成したことを特徴とするスポットライト。

## 【発明の詳細な説明】

## 【0001】

【発明の属する技術分野】 本発明は、テレビスタジオ及び舞台等々の照明演出空間のある部分にだけ光を照射するスポットライト照明器具及びその光源ユニットに関する。

## 【0002】

【従来の技術】 従来技術のスポットライトは、單一の光源が点光源であることを仮定の理論として白熱電球等の一つの光源から出る光を平凸レンズによって集光し、所定の方向に照射するとともに平凸レンズと光源の位置関係によって光りの広がりを変化させるものとして知られている。

【0003】 図1に従来技術の原理図を示す。光源(101)として、フィラメント(102)をできるだけ高温に熱して光を発生させるタンクステン電球及びハロゲン電球等の白熱電球が使われ、点灯すれば白熱電球を取り巻く全方向に光を照射する。

【0004】 この白熱電球が全方向に光を照射する結果として、実際に光を活用する前方方向に照射できる光束は全光束の1割位と言われている。

【0005】 また、全方向に光を照射するため平凸レンズ以外から光が直接洩れないようにカバー(109)で白熱電球を囲む必要があるが、白熱電球は可視光とともに多くの熱線を放射するため、熱に耐える鉄あるいは軽金属の板が使用され、また平凸レンズ(103)も耐熱性のガラスが使用されるので更にスポットライトが重くなり、スポットライトの移動に労力を要している。

【0006】 白熱電球から放射する熱線は、光漏れのために囲っている金属の板を熱し、人が素手で触れられず、扱い方によっては火傷をしたり、幕等の他のものとスポットライトが触れて火災が起きる危険性がある。

【0007】 フィラメントをできるだけ高温に熱して光を発生させる現在の白熱電球は、高温のため白熱電球の寿命が短く、思わぬ電球切れにより照明演出に支障をきたしたり、電球交換の手間及び電球切れに伴う白熱電球

の購入費用が多くかかっている。

【0008】スポットライトを運搬中に、白熱電球に振動及び衝撃を与えるとフィラメントの断線や封止ガラスの破損が起きる時がある。

【0009】この白熱電球は色温度が約3000K。位で、この白熱電球を光源としたスポットライトを野外の太陽光の下でテレビ及び映画の撮影で使用するためには、色温度を変換するフィルタをレンズの前に付け、周囲の色温度と合せる手間がかかる。

【0010】近年、白熱電球と異なる発光原理のメタルハライドランプ等の放電ランプがスポットライトに使われることもあるが、単一光源を仮定の理論にした照明原理は変わらず、またランプからの発熱も白熱電球に匹敵するぐらいある。

【0011】

【発明が解決しようとする課題】本発明は、フィラメントができるだけ高温に熱して光を発生させる光源を使用しているスポットライトの光活用効率の悪さ、金属板の使用及び耐熱ガラスの平凸レンズにより重い、火傷と火災の危険性、電球切れによる照明演出への支障、電球の短寿命による電球費用の多さ、対振動・衝撃の弱さ及び使用場所に色温度を合せる手間を解決する新しい光源の活用方式を提供することを目的とする。

【0012】

【課題を解決するための手段】上記目的を達成するため、本発明のスポットライトは次の解決手段を有する。

【0013】(1) 光源1：小型で振動・衝撃に強く、堅牢で信頼性があり、発熱が少なく、長寿命で、白熱電球の15lm/wに匹敵する発光効率を持ち、演色性が良く、指向性が狭角、例えば10°～20°の自発光型固体素子を採用する。その一例として、白色発光ダイオードを提示する。その概略的な特性は、材料にInGaN／YAGを使った化合物半導体のPN接合ダイオードの一種であり、電流を流し、接合部にキャリアを注入することで材料自身が発光し、白色の光を放ち、色温度が3000～10000Kで、発光効率が10lm/wで、動作電圧が3.6Vで、寿命が20000時間以上ある。

【0014】(2) 構成1：本発明の主な構成は、多数の前記光源1を有する光源1ユニットと、投射レンズとしての平凸レンズ又はフレネルレンズと、摺動台とからなり、(使用場所の光線の状態に応じて色温度を合せる手間を解決する手段はこれを含まないが、)高輝度を被照射面に与えるスポットライトを提供する。

【0015】(a) 光源ユニット1は、多数の前記光源1を有する半径を持つ曲面、例えば空洞の球体の外周球面、又は放物面の断片の一部に取付け、この外周面上に断片の多数の前記光源1の光のビームが光源ユニットの前方のある一点に集光するように調整したものである。

(b) 平凸レンズ又はフレネルレンズは、前記光源ユニット1によりある一点に集光した光源1の光のビームと

平凸レンズ又はフレネルレンズが固有に持つ焦点(F)との相対関係によって、被照射面の光の照度分布を拡散又は収束するものである。

(c) 摺動台は、前記光源ユニットと前記平凸レンズ又はフレネルレンズの位置関係を変化させ、前記光源ユニットによりある一点に集光させた前記光源1の光のビームとレンズの焦点(F)の関係により、選択的に被照射面の照度分布を拡散又は収束できるようにするものである。

(d) 前記光源ユニットと前記平凸レンズ又はフレネルレンズの位置関係を変化させる手段として、前記光源ユニットを固定して前記平凸レンズ又はフレネルレンズを動かす方法もある。

【0016】前記光源1に置換えることができる光源のひとつに、電界固体面状発光素子の一種である有機エレクトロルミネッセント素子(有機EL素子)をフレキシブルな構造にして曲面形状にするものがある。その概略的な特性は、有機蛍光体中に外部から電子とホール(正孔)を注入し、それらの再結合エネルギーによって発光中心を励起し、発光を生じるもので、高輝度(10万cd/m²以上)が可能で、高効率(10lm/W以上)であるものを青、緑、赤色の三種の発光層を積層することにより高輝度白色発光をするものである。このひとつの電界固体面状発光素子を前記光源ユニット1のように曲面構造にし、電界固体面状発光素子の照射ビームを前方の一点に集光させることにより、仮想の単一点光源を構成した光源ユニットも可能である。

【0017】(3) 光源2：小型で振動・衝撃に強く、堅牢で信頼性があり、発熱が少なく、長寿命で、白熱電球の15lm/wに匹敵する発光効率を持ち、演色性が良く、指向性が狭角、例えば10°～20°の自発光型の固体素子を採用する。その一例として白色発光ダイオードと、白色発光ダイオードの発光スペクトルに色温度3000Kを得るように発光スペクトルを加える黄色発光ダイオード、緑色発光ダイオード、赤色発光ダイオードとを光源とする。

【0018】(4) 構成2：本発明の主な構成は、色温度切替えスイッチ、前記光源2を多数有する光源ユニット、ビーム整形ディフューザー、投射レンズとしての平凸レンズ又はフレネルレンズと摺動台からなり、使用場所の光線の状態に応じて色温度を合せる手間を解決する手段を有するスポットライトを提供する。

【0019】(a) 色温度切替えスイッチは、前記光源2を有する光源ユニットの黄色発光ダイオード、緑色発光ダイオード、赤色発光ダイオードをオン・オフし、白色発光ダイオードの発光スペクトルに加える発光スペクトルを増減し、色温度切替えスイッチがオンの時は白熱電球と同じ色温度の光を照射し、スイッチがオフの時は野外と同じ色温度の光を照射する。

【0020】(b) 光源ユニットは、多数の前記光源2

をある半径を持つ空洞の球体の外周球面又は放物面の断片の一部に取付、この外周球面上の多数の前記光源2の光のビームが光源ユニットの前方のある一点に集光するように発光ダイオードの照射方向を調整したものである。

【0021】(c) ビーム整形ディフューザーは、前記の光源ユニットの前方にある一点に集光する位置に前記光源ユニットよりの支持金具で取付けて前記光源ユニットの動きと連動させ、集光点に集まつた前記光源2各色発光ダイオードより照射した固有の発光スペクトルを持つ狭角ビームの入射光をビーム整形ディフューザーが有する固有の拡散角により決められた範囲に拡散し、各色発光ダイオードよりのビームをむらなく混色し、平凸レンズ又はフレネルレンズに配光する。

【0022】(d) 平凸レンズ又はフレネルレンズは、前記光源ユニットによりある一点に集光した前記光源2の光のビームとレンズが固有に持つ焦点(F)との相対関係によって、被照射面の光の照度分布を拡散又は収束する。

【0023】(e) 摺動台は、前記ビーム整形ディフューザーが接続された前記光源ユニットと前記平凸レンズ又はフレネルレンズの位置関係を変化させ、前記光源ユニットによりある一点に集光させた前記光源2の光のビームとレンズの焦点(F)の関係により、選択的に被照射面の照度分布を拡散又は収束できるようにする。

【0024】

【発明の実施の形態】(第1の実施形態)

(a) 図2(a)及び図2(b)は、多数の前記光源1又は光源2を取付ける穴(202)がある半径50Rの空洞の球体のプラスチックできた外周球面の断片の光源取付球面板(201)を示す。

【0025】(b) 図3と図4の光源ユニット1(303、403)は、多数の指向性20°の白色発光ダイオードすなわち光源1(302、402)を光源取付球面板(301、401)に取付けて多数の前記光源1の光のビームが光源ユニット1の前方のある一点Fに集光して仮想の単一点光源(308、408)を作り、その後に光のビームがフレネルレンズ(304、404)に照射するように調整したものと示す。

【0026】(c) 図3と図4のフレネルレンズ(304、404)は、平凸レンズはガラスの厚みが厚くなり重くなるので、平凸レンズの曲面を分割して平面に寄せ集めた軽量のプラスチックのフレネルレンズを示す。

【0027】(d) 図3の作用は、前記光源ユニット1より照射されたビームをフレネルレンズが持つ固有の焦点F(307)に集光させて仮想の単一点光源(308)とし、フレネルレンズにより光を前方の被照射面(305)に光を収束させたことを示す。

【0028】(e) 図4の作用は、仮想の単一点光源(408)をフレネルレンズ(404)が持つ固有の焦

点F(407)よりフレネルレンズ側に光源ユニット1(403)をハンドル(406)で移動させ、フレネルレンズにより光を前方の被照射面(405)に拡散させたことを示す。

【0029】(f) 図5は、軽量のABS樹脂をハウジング(501)としたスポットライトのフレネルレンズ(504)の位置を固定し、仮想の単一点光源の位置を灯体下部に付けた光源ユニット1(503)と接続したハンドル(506)をフレネルレンズ方向又はその反対方向にて移動できるようにしたスポットライトを示す。

【0030】(g) 図5(a)及び図5(b)において、例えは軽量のABS樹脂をハウジング(501)としたスポットライトを示す。その光源ユニット1をハンドルをなくし固定することにより仮想の単一点光源の位置を固定し、フレネルレンズ(504)が取付けられたハウジング(501)を回転させてフレネルレンズの位置を仮想の単一点光源に近づけたり、離したりするようにしたスポットライトも可能である。

【0031】(第2の実施形態)

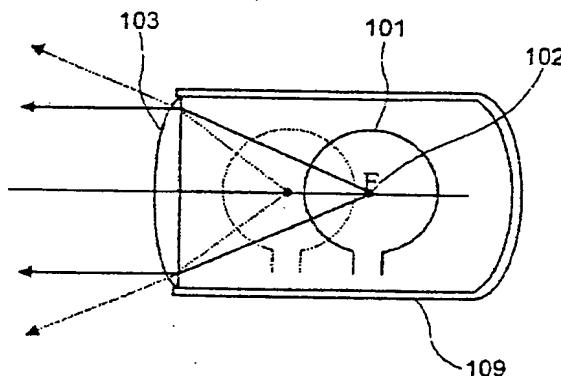
(a) 図6は、白色発光ダイオードに加えて色温度切替えスイッチのオン・オフによって黄色、緑色、赤色の発光を制御して色温度変える回路図を示す。色温度切替えスイッチ(603)がオフの時、外部直流電源(601)より供給された電流は、電流を制限する抵抗(602)を通って白色発光ダイオード(604)を流れ、色温度6000°Kの光を放つ。色温度切替えスイッチ(603)がオンの時、上記に加えて抵抗(602)を通って黄色、緑色、赤色発光ダイオード(605)にも電流が流れ、各色発光ダイオードも光を放ち、色温度3000°Kの光をトータルとして放つ。

【0032】(b) 図7の光源ユニット2(703)は、光源取付球面板(701)の前記光源ユニット1の光源1を仮想の単一光源の色温度を変えることができるよう各色発光ダイオードすなわち前記光源2(702)に置換えて前記仮想の単一点光源(708)を作り、光源ユニット1と同じ作用をするものであることを示す。

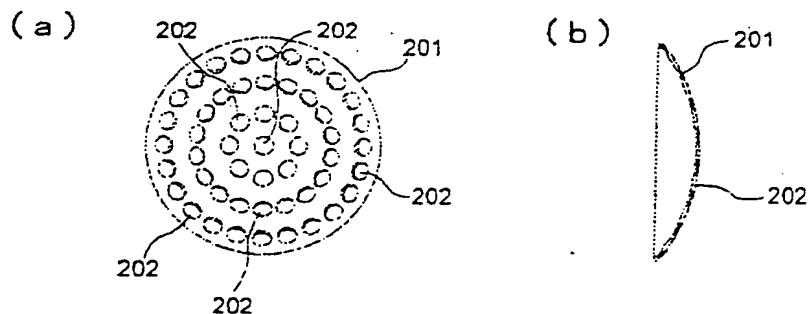
【0033】(c) 図7は、一例として拡散角20°の例えはポリカーボネイトのビーム整形ディフューザー(709)を前記の光源ユニット2(703)の前方にある一点に集光する仮想の単一点光源(708)の位置Fに配置するように前記光源ユニット2(703)の支持金具(711)から延長した支持金具(712)で取付け、集光点に集まつた各色発光ダイオードより照射した固有の発光スペクトルを持つ指向性15°～20°の入射光を、ビーム整形ディフューザーが有する固有の20°の拡散角により決められた範囲に更に拡散し、各色発光ダイオードよりのビームをむらなく混色し、フレネルレンズ(704)に配光しうるようとした。これにより、ビーム整形ディフューザーにより決められた拡散角

101	白熱電球	308, 408, 708	仮想の単一点光源の位置
102	フィラメント	501	ABS樹脂製のハウジング
103	平凸レンズ	601	外部直流電源
104	平凸レンズの焦点 (F) の位置	602	抵抗
109	カバー	603	色温度切替えスイッチ
201, 301, 401, 701	プラスチック製の光源取付球面板	604	白色発光ダイオード
202	光源取付穴	605	黄色、緑色、赤色発光ダイオード
302, 402	光源1 (白色発光ダイオード)	702	光源2
303, 403, 503	光源ユニット1	703	光源ユニット2
304, 404, 704, 504	プラスチック製のフレネルレンズ	709	ピーク整形ディフューザー
305, 405, 705	被照射面	711, 712	支持金具
306, 406, 706, 506	ハンドル	801	ガラス等の平面に構成された電界固体面状発光素子
307, 407, 707	フレネルレンズの焦点 (F) の位置	802	曲面のプラスチックフィルムに構成され高輝度白色発光をする有機エレクトロルミネッセント素子
		803	仮想の単一点光源の位置

【図1】



【図2】



を持つ光ビームなった後にフレネルレンズに照射された光は、第1の実施形態で述べた同様の作用を実現する。

【0034】(第3の実施形態) 一般に、図8(a)のようにガラス等の平面に構成された電界固体面状発光素子(S01)は、照射ビームを前方に照射する。図8(b)は、前記第1の実施形態の光源としてフレキシブルな構造とするためプラスチックフィルムを持ちいて、青、緑、赤色の三種の発光層を積層して高輝度白色発光をするひとつの有機エレクトロルミネッセント素子(S02)を曲面構造にし、素子の照射ビームを前方の一点に集光させることにより、仮想の単一点光源(S03)を構成した光源ユニットとしたこと示す。

#### 【0035】

【発明の効果】本発明のスポットライトは、以下の効果を有する。

【0036】(a) 既来のスポットライトは、電球等の単一光源により構成されていたため、前に述べたように電球に起因するいくつかの問題があったが、小さな多数の自発光型固体素子の光源により仮想の単一点光源を実現する方式で、ハウジングを軽量のA B S樹脂及び薄く軽量なプラスチックのフレネルレンズ等々の活用で既来の問題を解決できた。

【0037】(b) 新しい光源である自発光型固体素子は、被照射面の光の広がりを得ようとするときは、広角の照射タイプのものが使われるが、広角であるがゆえ被照射面の照度が著しく落ちる。また、狭角の照射タイプを使用すると照度は得られるが、光のむらがあったり、光の広がりが得られない矛盾があったが、狭角タイプの新しい光源を利用し仮想の単一点光源とした後レンズとの組合せにより、高い照度と光のむらがなく光の広がりをもつ両方の特性を得ることができた。

【0038】(c) 狹角照射タイプを使用しても1個又は少數個の単なる集合体では演出空間の光としては照度が不十分である。本発明は球体曲面又は放物面の面上に自発光型固体素子を配列することにより、単に平面に自発光型固体素子を取付けるよりも約1.8倍の数の素子を取付けられ、レンズとの組合せによりレンズとない時と比べて約2.5倍の照度アップを得ることができた。

【0039】(d) 自発光型固体素子を用いて色温度切替えを光のむらをなくして行うためには、発光ダイオードディスプレーで見られるように素子の外形を限りなく小型にしなければならないし、多くの素子が必要である。素子の外形を小型にすることは照射ビームの量が少なくなるので光のむらをなくし、照度を得ることに矛盾があつたが、照射ビームの多い外形の大きな素子による仮想の単一点光源の方式とビーム整形ディフューザーの組合せにより、光のむらを無くし、高い照度を得ることができた。

#### 【0040】(e) 本発明の活用は演出空間にとどまら

ず、いろいろな分野に活用できる。例えば、より鮮やかな映像を得るために色温度6000K<sup>o</sup>の光源を必要としている水中ライトは、色温度6000K<sup>o</sup>を得る光源が水銀とアルゴンの蒸気中にハロゲン化合物を混入して電極間の放電によって光を放つメタルハライドランプ

(HMI)等の高圧バルスを出す放電灯のため漏電による感電の危険性と防水ケース内のランプの温度上昇が高いため実用化されていないが、低電圧で駆動でき、温度上昇が少ない自発光型固体素子の水中スポットライトがこの方式で可能となる。

【0041】(f) 文化財や美術品を撮影する時の照明器具の光源として、白熱電球は発光スペクトルが連続スペクトルであり赤外線を放射し、撮影対象物に熱による悪い影響を与える。白熱電球に変わるものとして撮影の際に使われる放電灯の一種であるメタルハライドランプは、紫外線により対象物の劣化を促進する問題がある。この問題によりこれらの光源を使用した照明器具を使う時は赤外線また紫外線をカット・吸収するフィルタを使用している。そして、この2種類の光源は放射温度が高い光源であるため対象物への照射時間を短くしなければならない。

【0042】発光スペクトルが帯域の狭い輝線スペクトルであり、放射温度の低い自発光型固体素子を使用すれば赤外線、紫外線及び放射温度が高い問題が解決できるであろうことは予測できたが、撮影に必要な照度を得られない大きな問題があつて使われていなかった。

【0043】本発明は、これらの問題を解決して、文化財や美術品の撮影を簡便に可能にした。

#### 【図面の簡単な説明】

【図1】既来の一般的なスポットライトの原理を示す図である。

【図2】本発明の光源ユニットを構成する光源取付球面板を示す図であつて、(a)は正面図、(b)は断面図である。

【図3】光を被照射面に収束させた状態を示す図である。

【図4】光を被照射面に拡散させた状態を部分的に断面で示す側面図である。

【図5】実際のスポットライトの形状を部分的に断面で示す図であつて、(a)は正面図、(b)は側面図である。

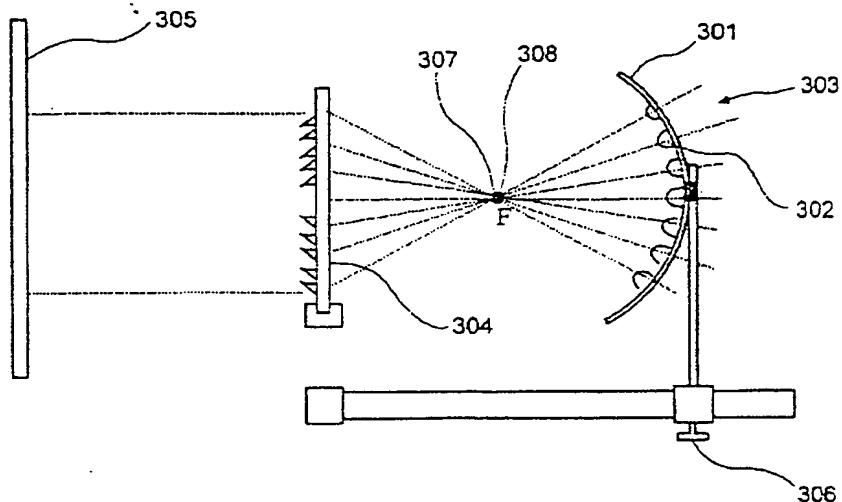
【図6】色温度切替えスイッチによって色温度を変えるための回路を示す図である。

【図7】各色発光ダイオードよりの光のビームをむらなく混色し、被照射面に収束させる仕組みを示す図である。

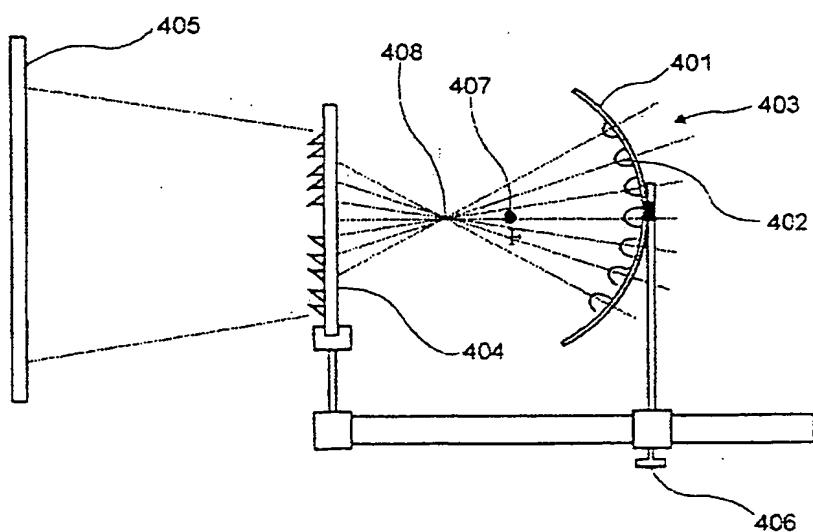
【図8】プラスチックを持ちいて高輝度白色発光をするひとつの有機エレクトロルミネッセント素子により仮想の単一点光源ができるることを示す図である。

#### 【符号の説明】

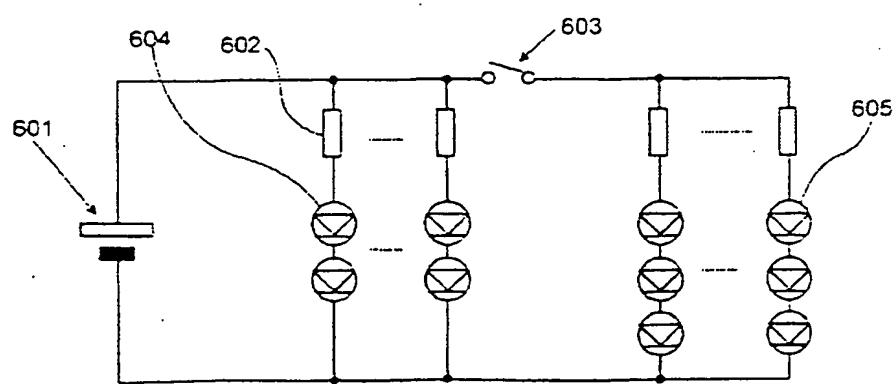
【図3】



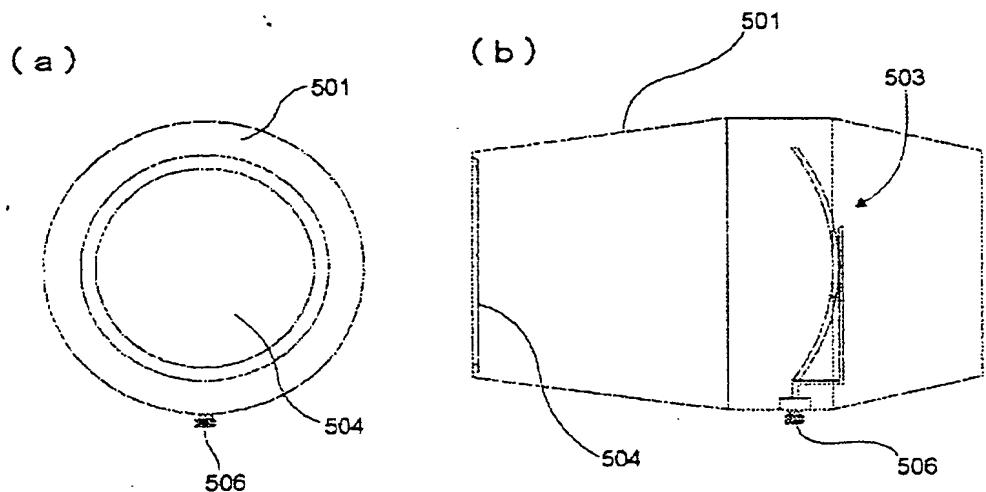
【図4】



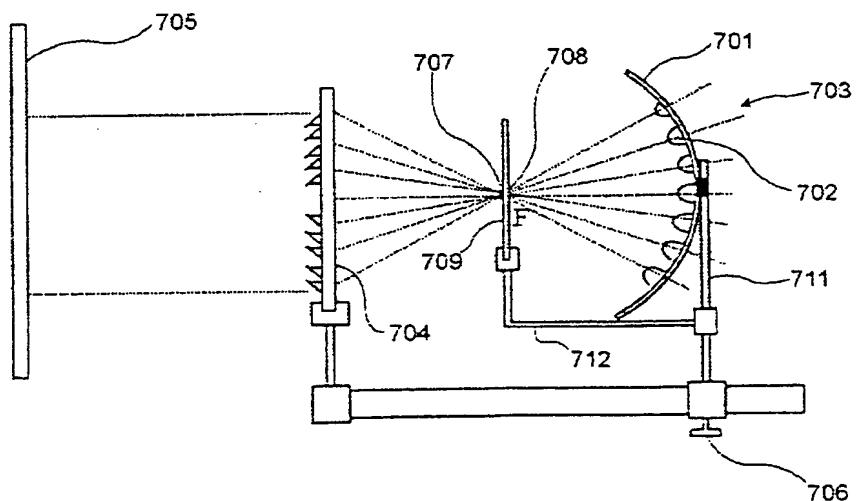
【図6】



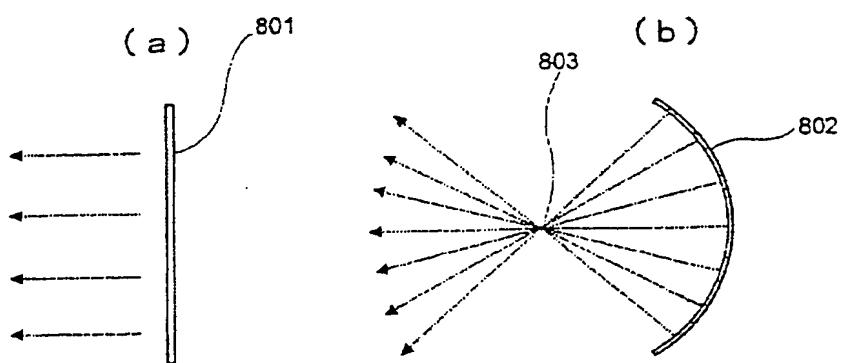
【図5】



【図7】



【図8】



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